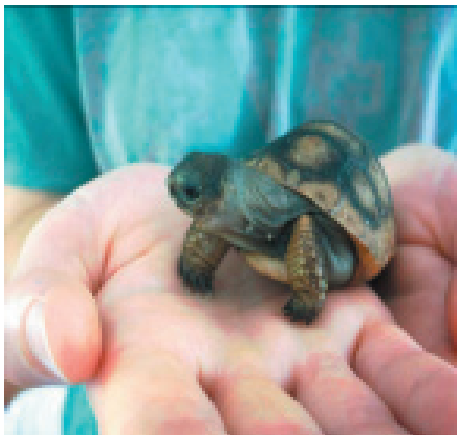


Phelsuma

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Contents

Editorial	1
Chairman's report	2
2001-2002 Publications	4
Captive breeding of <i>Dipsochelys</i> giant tortoises	<i>J. Gerlach</i> 8
Tetragnathid spiders of Seychelles (Araneae, Tetragnathidae)	<i>M.I. Saaristo</i> 13
Species list and relative abundance of marine molluscs collected on Aride Island beach between March 2001 and February 2002	<i>J.S. Agombar, H.L. Dugdale, N.J. Hawkswell</i> 29
New terrestrial Gastropoda (Mollusca) from Seychelles	<i>J. Gerlach</i> 39
The relationships between length and weight of the Aldabra giant tortoise <i>Dipsochelys dussumieri</i> in Mauritius	<i>L. Aworer & R. Ramchurn</i> 52
Factors influencing emergences and nesting sites of hawksbill turtles (<i>Eretmochelys imbricata</i>) on Cousine Island, Seychelles, 1995-1999	<i>P.M. Hitchins, O. Bourquin, S. Hitchins & S.E. Piper</i> 59
Notes	
Inter-island nesting by hawksbill turtles (<i>Eretmochelys imbricata</i>) in Seychelles	<i>P.M. Hitchins, O. Bourquin & S. Hitchins</i> 70
Ghost crabs (<i>Ocypode</i> spp.) of Bird Island, Seychelles	<i>J.M. Lawrence</i> 71
Inconclusive published and museum bird records from Seychelles	<i>A. Skerrett & Seychelles Bird Records Committee</i> 72
First record of the family Chrysidae (Insecta: Hymenoptera) from Seychelles	<i>J. Gerlach & M. Madl</i> 77
New plant records for the granitic Seychelles islands	<i>J. Gerlach</i> 78
Observations on some reptiles in Seychelles	<i>P. Matyot</i> 80
Observations on the Seychelles tree frog living in residential habitats	<i>G. Rocamora</i> 84

The state of scientific research in the western Indian Ocean currently appears to be very healthy. This is reflected in the increased number of manuscripts submitted to *Phelsuma*, resulting in this year's issue being the largest produced to date and several manuscripts being held over to next year. This year we carry papers and notes on everything from insects to reptiles and birds, and faunal records and taxonomy to conservation and breeding biology. Our geographical coverage also remains good, including Seychelles, Glorieuse and Mauritius; in total we deal with 45 of the Seychelles islands. It is particularly encouraging to see the publication of notes on the biology of familiar, but little studied animals, such as the Seychelles tree frog, and some of the turtle records from Cousine island. Science in the region is still held back by a common reluctance to publish. This 'data hoarding' effectively makes the data collected worthless while preventing others from carrying out new, publishable research.

The publications lists in this year's issue also reveal the encouraging trend towards increased research and publication. In 2002 48 papers were published relating to Seychelles. This number has not been reached since the days of the Royal Society and Smithsonian Institution involvement with Aldabra. The 2002 papers show a reasonable coverage of taxonomic groups (although still vertebrate biased): plants 14%, invertebrates 40% and vertebrates 46% (with birds alone forming 34%). Regarding topic, taxonomy is the dominant subject (33%), followed by ecology and conservation (both 9%). The terrestrial environment dominates (83%) (83%), as do the granitic islands (granitics 89%, 5% Amirantes, 6% Aldabra). These simple comparisons indicate that although the rate of publication is high there are relatively few publications resulting from the extensive research that has been carried out over the past 2-3 decades on the marine life (especially corals and turtles), plants and terrestrial invertebrates. We will continue to encourage these gaps to be filled and build on the great progress of the

CHAIRMAN’S REPORT

We achieved two major conservation goals this year with the first hatching of baby Seychelles and Arnold’s giant tortoises, and with the first release of captive-bred terrapins into the wild. It will be some years before the tortoises can be released into the wild on Silhouette, as they will remain vulnerable until they are about 5 years old. The Seychelles Terrapin Action Plan (Supplement to *Phelsuma* 10) will benefit from the current and future hatchlings from our captive breeding project. The Action Plan was designed by Justin Gerlach with input from various specialist bodies and local organisations. It has been accepted and is now being implemented.

Although attending meetings on Mahé is both expensive and time consuming, we have endeavoured to participate in those committees that are of direct concern to us. Jimmy Valentin has now taken over from Pat Matyot as NPTS representative on the Steering Committee for the Environment Management Plan for Seychelles 2000-2010. The Chairman is the representative on two newly-formed groups; the National Parks Committee and a focus group in support of the Government’s “Vision 21” on eco-tourism. Our membership of LUNGOS (Liaison Unit for Non-Government Organisations) lies in the balance at the end of this financial year. There are no apparent benefits to NPTS from membership of this organisation and the annual fees would be better spent on conservation projects. In contrast, our membership of IUCN is more expensive but the benefits include representation on several specialist groups of the Species Survival Commission and a real opportunity to influence the areas of conservation in which we have some expertise.

Most of our fund-raising has, as usual, been through the sale of goods in our Information Centre and the donations made by visitors to the projects. The following individuals and organisations have helped in other ways:

equipment	Peter Kistler of SAN	Donation for equip-
	Bill & Gabriella Humphries	Donation
	Tom & Judy King	Equipment
	Mr. & Mrs. D. Hurst (LAPA Charitable Trust)	Equipment
Terrapin Food	Rolph Hagen	Equipment & Ter-
	Hon. J. Cator (Ranworth Trust)	Donation
	SWR (ARD) Television	Equipment
	Turtle Conservation Fund	Project support
	Seychelles Marketing Board	Equipment
	Islands Development Company	Logistic and other support
	KPMG Pool & Patel	Honorary auditors

Our grateful thanks to all, and for their support and encouragement.

Visiting Scientists

The following scientists spent time on Silhouette:

- Dr. Michael Madl, a wasp specialist from Vienna, Austria (twice)
- Christoph Kueffer and Eva Schumacher, botanists from Switzerland working on invasive species
- Dr. Christophe Laverne, invasive species specialist from La Reunion
- Germinal Roulan of the Paris Natural History Museum, researching *Elaphoglossum* ferns
- Alistair Griffiths, botanist from the Eden Project, U.K, researching *Impatiens gordonii*
- Renaud Boistel, from Universite Paris Sud, carrying out research on sooglossid frogs
- Sussex University field course led by Drs. Michael Frogley and Dominic Kniverton
- Dr. Daniel Lachaise, from Centre Nationale de la Recherche Scientifique, Paris, carrying out research on the current biodiversity of fruitflies of Seychelles.

Overseas Visits and Meetings

In January, while in South Africa, we had the chance to visit the offices of Wilderness Safaris who are one of the partners on North Island. The purpose of the visit was to discuss the possibility of their involvement in the building of a camp at Mare aux Cochons, as part of a round Silhouette trail. Discussions will continue once the hotel on North is up and running.

Seychelles Giant Tortoise Conservation Project

In early November, Jules Larue, our assistant on Silhouette, noticed an egg hatching in the tortoise incubator. On 7th November, the first of two *Dipsochelys hololissa* hatchlings emerged. The female “Josephine” and the male “Adam” are both of this species. The incubation time was 125 days. This clutch, which consisted of 22 eggs, had been divided into three (one third left in the natural nest, one third in an artificial nest and the remainder in the incubator) The two eggs which hatched were in the incubator. One of the unhatched eggs remaining in the incubator contained an almost full-term hatchling which had perished before hatching. All other eggs, when opened were infertile.

On 12th December, hatching eggs from the *D. arnoldi* female “Betty” and either of the males, “Hector” (*D. arnoldi*) or “Christopher” (*D. hololissa*) were observed. Three hatchlings emerged, bringing the total up to 5 hatchlings for the season. Incubation time varied from 130-136 days. As with the *D. hololissa* eggs, all unhatched eggs proved to be infertile. In this case the clutch size was 6 eggs (50% success). A later clutch of 7 eggs which were placed in an artificial nest were unearthed after 230 days and 4 were found to be broken - possibly due to pressure on the ground above, and the remaining 3 were infertile.

Our over-cautious handling of these, the first-ever hatchling tortoises for the project, almost resulted in disaster. The hatchlings were kept indoors as a security measure and were fed on the natural food of their choice *Asystasia* sp. - a relatively low value food plant. At 3 months the first two hatchlings showed signs of losing the ability to stand or walk properly. With advice from UK vet Mike Jessop, and calcium carbonate/Vitamin D tablets rushed to Silhouette by Mr. Berham - a pharmacist on Mahé, we were slowly able to reverse the problem and get the

invalids back on their feet. They were all moved to an outdoor enclosure with ample sunshine and more highly Ca/P rated food included in their diet. At the end of their first six months, all the hatchlings are doing well, with the largest having quadrupled its birth weight.

Seychelles Terrapin Conservation Project

With publication last year of the Seychelles Terrapin Action Plan work has started on the implementation of the plan. This year, 12 juvenile *Pelusios subniger* were released into the marsh at Grande Barbe, Silhouette. These captive-bred terrapins joined the five adults that were released in the same area last year. The reduced number of adults in our enclosures produced 7 hatchlings last season. Breeding success with *P. castanoides* eluded us again this year. For the first time ever we had two females dig normal nests and lay 13 and 11 eggs each. These eggs did not respond as well to artificial incubation as the *P. subniger* eggs and did not develop.

Silhouette Conservation Project

This year has seen a huge increase in the number of visitors to Silhouette, most of whom visit our Information Centre and the tortoise project. In May we received our first visitors from North Island's new hotel. The number of scientific visitors have also increased, showing the importance of the level of biodiversity on Silhouette. Our laboratory has been well used by these scientists and they have found the facility a great help.

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Captive breeding of *Dipsochelys* giant tortoises

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Abstract: The Seychelles Giant Tortoise Conservation Project captive breeding programme for the Seychelles tortoises *Dipsochelys arnoldi* and *D. hololissa* is described. Successful hatching occurred in 2002 and the reasons for this success discussed. Important factors are enclosure design, social structure and the use of artificial incubation. Methods for sexing hatchlings are discussed. There may be great potential in manipulating social structure to encourage breeding in otherwise difficult taxa, such as the Galapagos tortoise *Chelonoidis nigra*.

Key words: anatomy, conservation, giant tortoise, social structure

Introduction

Indian Ocean giant tortoises have a long history in captivity, having been kept since the 1600s. Despite this history captive breeding of the surviving Aldabra-Seychelles genus *Dipsochelys* remains relatively rare, with occasional breeding in Britain, the U.S.A., Australia and Japan. The only regular breeding occurs in Mauritius and Seychelles. Even in Seychelles the vast majority of captive tortoises do not breed.

The rediscovery of the Seychelles giant tortoises *D. hololissa* (Günther, 1877) and *D. arnoldi* Bour, 1982 led to the creation of the Seychelles Giant Tortoise Conservation Project by the Nature Protection Trust of Seychelles in 1997. The project brought together the few surviving individuals of these species and housed them in large, semi-natural enclosures. The experiences of other *Dipsochelys* tortoise keepers were compiled through direct discussions and other sources (Ebersbach 2001; Schils & Smeets 2001). This resulted in successful captive breeding in 2002. The methods used to achieve this success are described below.

Enclosures and social organisation

The captive breeding project is based in three large enclosures on Silhouette island. Each enclosure measures approximately 30x40m, housing 13 tortoises. These comprise 3 adult male and 3 adult female *D. arnoldi*; 3 adult male, 1 subadult male and 2 adult female *D. hololissa*; and a juvenile *D. dussumieri*. The enclosures contain natural plants, trees, shelters, muddy wallows and supplies of clean drinking water (Fig. 1).

From 1997 to 2001 the species were kept separate with *D. hololissa* (and the *D. dussumieri* juvenile) in one enclosure and the *D. arnoldi* in another. The third enclosure was only used seasonally, when females were separated from the males in order to encourage mating during the breeding season. From 2002 all tortoises were allowed free movement between the enclosures following advice that successful breeding was only likely with a large group, preferably of at least 12 tortoises (O. Griffiths pers. comm.). Mating success appeared to improve after this change and fertile eggs were produced for the first time.



Fig. 1. *D. hololissa* (right) and *D. arnoldi* (left) in enclosures on Silhouette island

Incubation

Since the first eggs were laid in 1999 most clutches were incubated artificially. In 2002 three alternative incubation methods were tried: artificial incubation, reburial in a secure site and natural, undisturbed incubation. This year saw the first hatchlings, all from eggs incubated artificially. None of the eggs incubated in the ground hatched; there was no sign of development in reburied eggs and most of the natural nests were destroyed by crabs.

Successful artificial incubation was achieved using an incubator with over 80% humidity and set at 29°C (28-30°C). The 2001 temperature resulted in hatchlings after 125-136 days which would be expected to be males. The temperature was altered in 2003 to over 30°C (30-32°C) to produce females, and hatching occurred at 90-94 days (Fig. 2).

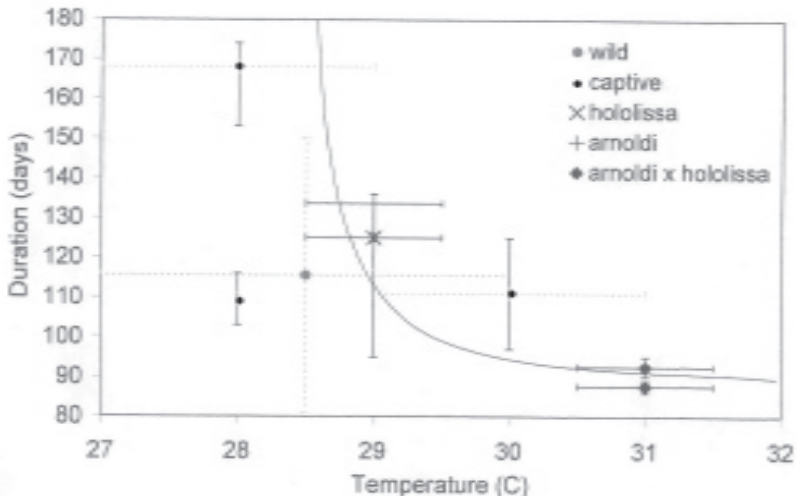


Fig. 2. Results of artificial incubation (based on published data for *D. dussumieri* and new data on *D. arnoldi* and *D. hololissa*).



Fig. 3. *Dipsochelys hololissa* (left) and *D. arnoldi* (right) hatchlings

Hatchling morphology

The 2002 hatchlings comprised both *D. arnoldi* and *D. hololissa* (Fig. 3). The external morphology was compared to investigate species differences (Gerlach & Bour 2003). The first 2003 hatchlings represented hybrids between these two species, and accordingly they show variable external morphology. In 2002 one *D. hololissa* full-term embryo died prior to hatching and in 2003 one of the hybrids died during the hatching process. Both of these were dissected to investigate the internal anatomy and to confirm the presumed sexes of the clutches.

Anatomy

The anatomy of *Dipsochelys* giant tortoises is described in detail in Gerlach (2003). Hatchling anatomy is identical to that of the adults in most respects. Partial musculoskeletal dissections are shown in Fig. 4. The only feature of the internal anatomy not previously figured is the brain (Fig. 4), this closely resembles that of other tortoise species. The skull is notably poorly developed, with no mandibular denticles and no supra-occipital crest. It is notable that the skull at this stage is very similar to that of the Madagascar spider tortoise (*Pyxis arachnoides*), a genus which is closely related to *Dipsochelys*, and may be a paedomorphic derivative from a Madagascan common ancestor (Palkovacs *et al.* 2002).

The dermal components of the carapace are not ossified in the hatchling material, with the carapace being composed of the dorsal vertebrae and ribs only. The vertebrae are all distinct and the 8th dorsal vertebra 75% of the length of the 7th (similar to adult *D. hololissa* but distinct from *D. dussumieri*).

Sexing the embryos proved to be less clear than published accounts imply (Swingland & Coe 1979). Both dissections revealed identical reproductive tract morphology despite the clear differences in incubation time and duration, factors which are expected to result in different sexes. The cloaca of both embryos contained a distinct penis-like structure. This was relatively small but structurally identical to the adult male penis. The gonads were elongate, brown structures positioned dorsally to the kidneys. No clear internal structure could be discerned. From these dissections it appears that the reproductive tracts of male and female tortoises is not differentiated until after the hatchling stage. It is probable that

the penis precursor does not develop any further in the female, remaining a small area of erectile tissue, developing into the full penis structure in subadult males. Gonad differentiation may also take place relatively late. This late differentiation means that embryonic and hatchling tortoises cannot be sexed on the basis of reproductive tract morphology, despite published reports of hatchling sex ratio determined by dissection (Swingland & Coe 1979). An alternative sexing method may be possible using the external morphology of the tail. This is distinctly longer in adult males than in females, but no such difference is present in hatchlings. As the tail elongates males do not grow additional scales but expand the existing scales, thus the number of tail scales gives an indication of the adult tail length (I.R. Swingland pers. comm.). The embryo and hatchling tail scale counts are shown in Table 1. These support the expectation that the low temperature 2002 hatchlings are male whilst the higher temperature 2003 hatchlings are female.

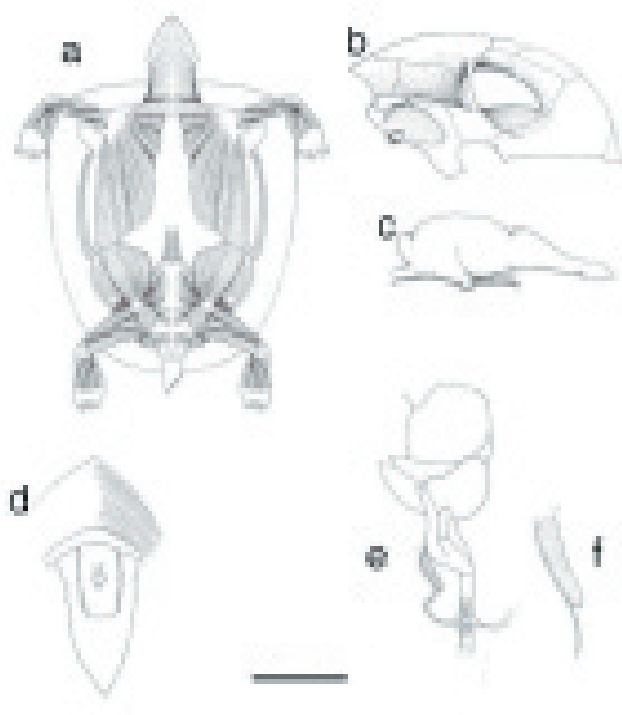


Fig. 4. Hatchling *D. hololissa* anatomy. a) superficial musculature ventrally; b) skull laterally; c) brain laterally; d) sectioned cloaca dorsally, showing erectile organ; e) urogenital system; f) detail of goand. Scale bar: a - 15mm; b&f - 3mm; c&d - 2mm; e - 10mm

Table 1. Tail scale counts of artificially incubated hatchlings (range and mean)

Species	Incubation temperature	N	Tail scales	Presumed sex
<i>D. arnoldi</i>	28-30	3	12-(13.8)-14	male
<i>D. hololissa</i>	28-30	2	14	male
<i>D. arnoldi</i> x <i>hololissa</i>	30-31	7	8-(9.0)-11	female

Discussion

The successful captive breeding of both *D. hololissa* and *D. arnoldi* in 2002 are the result of providing the adult tortoises with suitable conditions. These comprise large, varied enclosures, plentiful natural foods (notably high in calcium) and an appropriate social grouping. The combination of spatial and social variability enables the females to avoid the males when they wish to do so and reduces tensions in the captive group. A relatively large group (12 or more individuals) encourages some degree of competition between the males which seems to be needed to stimulate successful mating. Under captive conditions (where a full selection of nest sites cannot be provided) artificial incubation is the most effective method. This requires high humidity levels (over 80%), the critical temperature for sex determination is believed to be 29°C.

These methods have been developed specifically in order to achieve successful captive breeding of *Dipsochelys* giant tortoises but they may also have application to other species. The social aspect of tortoise behaviour is often overlooked, although it is known to be vitally important in the breeding of the plough-share tortoise *Astrochelys yniphora* (Vailant, 1885) (McKeown *et al.* 1982) and is significant in the Galapagos tortoises *Chelonoidis nigra* (Quoy & Gaimard, 1824). Stimulating male-male competition in tortoise breeding has only been explicit in the Seychelles Giant Tortoise Conservation Project and in projects to breed the plough-share tortoise but could be the key to successful breeding of other Critically Endangered taxa. The most famous tortoise needing such a novel approach, and perhaps the most likely to respond, is the last surviving male Pinta Galapagos tortoise *C. nigra abingdoni* (Gunther, 1877) 'Lonesome George'.

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Tetragnathid spiders of Seychelles (Araneae, Tetragnathidae)

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Abstract: Ten tetragnathid species are reported from the granitic Seychelles. The male of *Leucauge argyrescens* Benoit, 1978 is described for the first time. The following synonyms are presented: *Leucauge russel-smithi* Locket, 1980 = *Leucauge argyrescens* Benoit, 1978 n. syn., *Tetragnatha modesta* Hirst, 1911 = *Tetragnatha ceylonica* O. Pickard-Cambridge, 1869 n. syn., *Tetragnatha foliifera* Simon, 1898 and *Tetragnatha grenda* Roberts, 1983 = *Tetragnatha demissa* L. Koch, 1872 n. syn. and *Tetragnatha infuscata* Benoit, 1978 = *Tetragnatha boydi* O. Pickard-Cambridge, 1898 n. syn.. Also two new combinations are established, viz. *Mesida thorellii* (Blackwall, 1877) n. comb. and *Tylorida mornensis* (Benoit, 1978) n. comb. Finally the single loose chelicera found among detritus and considered by Benoit (1978a) to belong to some theraphosid is represents a femlae *Nephila inaurata* right chelicera.

Key words: Araneaea, Spiders, Seychelles, Tetragnathidae.

Introduction

The tetragnathids are small to large (2-50mm) entelegyne orbweb spiders. For the most part their bodies are elongated with long and slender legs. There are eight eyes in two rows. Maxillae distinctly longer than broad. Their chelicerae are of great size and often markedly elongated in males; hence they are often called big-jawed spiders. In the male palp there is a separate sclerite hinged with the proximal end of the cymbium and usually called the paracymbium. The same term is also used in this study although it is not thought that it is necessarily homologous with the paracymbium found in the family Linyphiidae. Similarly the term conductor is here used as a functional term without taking any position as to its homology with the same kind of structure in other families. The inner structures below the epigyne are commonly called vulva or vulval structures. This terminology is however misleading and instead I have used the alternative term adnexae.

The Tetragnathidae are a fairly large family with some 50 genera and about 9000 species. Most tetragnathids live in grassy places and are particularly common on the borders of swamps and corresponding habitats. The Seychellian tetragnathids can be placed in three subfamilies; viz. Nephilinae, Leucauginae, and Tetragnathinae. Females of the Nephilinae are the largest of all the orb weavers, often more than 5 centimetres long and with legs that sometimes span 20 cm. On the other hand the males are conspicuously small dwarfs. Conington *et al.* (1997) have suggested that this dimorphism is due to the female gigantism rather than male dwarfism. Nephilines are remarkable for the strength of the silk they spin and are rightly known as the silk spiders. Their great round webs of golden silk, which are sometimes more than one meter in diameter, are often made high in trees, electric wires etc. Leucacini species have a more or less silvery abdomen with patterns of red, green and gold marks. They also have relatively large vertical or almost horizontal webs which they spin in vegetation in damp places. Members of Tetragnathinae are characterized by the significantly elongated bodies and chelicerae and long, slender legs; but there are also species which have almost globose abdomens such as those belonging to the genus *Dyschiriognatha* Simon, *Phelsuma* 11 (2003); 13-28

1893. *Tetragnatha* spp. usually construct horizontally inclined orbwebs, near or above streams and ponds. The webs are short-lived as they are taken down and digested daily or even more frequently. Members of *Dyschiriognatha* are mainly found in the lower litter layer. Interestingly almost all tetragnathids have kleptoparasites on their webs (see Saaristo 2000). At present, ten tetragnathid species are known from Seychelles.

New island records presented in this paper are indicated by an asterisk.

subfamily Nephilinae

Genus *Nephila* Leach, 1815

Nephila inaurata (Walckenaer, 1842); palm spider (Fig. 1)

Epeira inaurata Walckenaer, 1842: 94 (Df).

Epeira madagascariensis Vinson, 1863: 191, 311, pl. 7, f. 1 (Df).

Nephila inaurata, Simon 1864: 276.

Nephila inaurata seychellensis Canard, 1975: 778 (Df).

Nephila inaurata, Saaristo 1978: 119, f. 203-210 (mf).

Gen. sp. ign., Benoit 1978a: 418, f. 5G-H.

Nephila inaurata madagascariensis, Benoit 1978b: 673 (= *ssp. seychellensis*).

N.B. For more references see Plactnick (2003).

Material examined: Aldabra, Picard, 1m1subad.m1subad.f1juv., Dec. 2000, P. Matyot leg. (MZT AA 2.240); Alphonse, 1m, 08.04.2001, J. Gerlach leg. (MZT AA 2.149); Aride, 3m1f3juvs., 1975, M. Mühlenberg leg. (MZT AA 0.228-0.230), 1m9juvs., 27.-28.02. 1999, J.Cadbury & E. Andrews leg. (MZT AA 1.266-1.267), and litter sampling, 2juvs., July-November 2000, John Bowler leg. (MZT AA 2.136); Bijoutier, 1m, 08.04.2001, J. Gerlach leg. (MZT AA 2.196); Bird, sweeping., 2juvs., March 2000, Hill & Vel/ BLG leg. (MZT AA 1.832); Cerf, 1juv., 11.12.2001, J. Gerlach leg. (MZT AA 2.310); Cocos, 1juv., 22.03.2002, J. Gerlach leg. (MZT AA 2.308); Conception (#194), sweeping., 4juvs., Febr. 2000, Hill & Vel/ BLG leg. (MZT AA 2.089); Cousin, 4m, 30.03.1978, Hugh Watkins leg., M. Saaristo det. (MZT AA 0.231) and 4m, 1978, H. Watkins leg. (MZT AA 0.231-0.232); Cousine, web, buildings, 1subad.m 1fjuv., 10.10.1996, O. Bourquin leg. (MZT AA 0.383) and from web, 1f, 16.05.1997, P. Hitchins leg. (MZT AA 0.388); Curieuse, sweeping., 2m25juvs., January 2000, Hill & Vel/ BLG leg. (MZT AA 1.830-1.831, 2.083); Denis, sweeping., 2m25juvs., Oct. 1999 – April 2000, (MZT AA 1.-1.813, 2.091-2.093); Felicite, sweeping., 19juvs., Nov. 1999, Hill & Vel/ BLG leg. (MZT AA 1.821-1.827) and 1juv., 24.03.2002, J. Gerlach leg. (MZT AA 2.291); Grande Soeur, 1juv., 22.03.2002, J. Gerlach leg. (ZT AA 2.327); Isle aux Vaches Marines, 1juv., 5.4.2003, J. Gerlach leg. (MZT AA 2.389); Mahé: various places, 15mm7ff, 27.-30.10.1975, M. Saaristo leg., 1subad., 12.07.1994, J. Gerlach leg., and 6m, Jan. 1999, M. Saaristo, P. Matyot and M. Kirkpatrick leg. (MZT AA 0.039, AA 0.233, and AA 0.539-0.541); Marianne, sweeping., 1subad.m.81juvs., 23.10. 1999, Hill & Vel/ BLG leg. (MZT AA 1.814-1.820, 2.340); North, sweeping., 2m1f30juvs., May 1999 – Jan. 2000, Hill & Vel/ BLG leg. MZT AA 1.833, 2.084-2.090, 2.115) and 1m, 30.07.2000, J. Gerlach leg. (MZT AA 1.352); Round Is. (Praslin), 2juvs., March 2002, J. Gerlach leg. (MZT AA 2.280, 2.406); Silhouette, La Passe, 1m, 19.01.1999, M. Saaristo leg. (MZT AA 0.542) and *Pisonia* forest, from stomach of *Nesomantis thomasetti*, 1juv., 08.08.1990, J. Gerlach leg. (MZT AA 2.141); St. Pierre, 1juv., Oct. 2001, J. Gerlach leg. (MZT AA 2.396); St. Francois, 1m, 08.04.2001, J. Gerlach leg. (MZT AA 2.200); Therese, sweeping., 14juv., Sept. 1999, Hill & Vel/ BLG leg. (MZT AA 1.828-1.829).

Diagnosis: The adult female is easily recognized by its huge size, total length: 28.3 - 30.7mm, and golden web. The size difference of the two sexes is very great. Total length: m = 3.7-6.9mm, f = 28.3-30.7mm; length of carapace: m = 1.9-3.2mm, f = 10.0-13.3mm. The male is recognized by having long, slightly S-shaped conductor inclosing the whip-like embolus. The conductor is ca. 1.5 times the diameter of the bulb and it can be observed with the naked eye; also the subadult males are easily recognizable due to the conspicuous cone-like elevation of the developing palp.

Description: The species has been well described by Saaristo (1978).

Distribution: The female of this species is the most handsome and conspicuous Seychelles spider and locally known as the palm spider. In suitable places it is very abundant. Its is known from Madagascar, Rodriguez, Mauritius, Aldabra atoll and found on the following Seychelles islands: Alphonse (*), Aride (Bowler *et al.* 1999), Bijoutier (*), Bird (*), Cerf (*), Cocos (*), Conception (*), Cousin (*), Cousine (Saaristo 1999), Curieuse (Benoit 1978b), Denis (*), Felicite (*), Frégate (Benoit 1978b), Grande Soeur (*), Isle aux Vaches Marines (*), La Digue (Benoit 1978b), Mahé (Simon 1898: *N. madagascariensis*), Hirst 1911, Benoit 1978b, Saaristo 1978, 1999), Marianne (*), North (*), Praslin (Hirst 1911), Benoit 1978b), Round Is. (Praslin) (*), St. Francois (*), Silhouette (Hirst 1911, Benoit 1978b, Saaristo 1999) and Therese (*). In addition it has been observed on Anonyme, Islette, Rat, Round (Mahe) and St. Anne (J. Gerlach pers. comm.).

Remarks: The female of *N. inaurata* hangs head-down in the middle of its web accompanied several dwarf males. Further there are usually numerous cleptoparasitic *Argyrodes* specimens (often of more than one species) around the perimeter of the web.

Discussion: I have not been able to study the differences between the nominal species *N. inaurata* and *N. i. madagancaries* and have treated them as a single taxon.

Benoit (1978a: 418, Fig. 5G-H) described a single chelicera found loose among litter considering it to belong to some mygalomorphid spider. It was collected on Mahé, Morne Blanc. I have seen this sample (MRAC 143.091) and there is no doubt that it belonged to a female of *N. inaurata* (Fig. 1).



Figs. 1-4. *Nephila inaurata* (Walckenaer, 1841). - 1: Right female chelicera from behind; a loose chelicera from Mahé, believed by Benoit (1978a) to belong some mygalomorphid spider (MRAC 143.091). – Scale bar = 0.2 mm. - Orig.

Genus *Nephilengys* C. L. Koch, 1872

Nephilengys cruentata (Fabricius, 1775)

Aranea cruentata Fabricius, 1775: 439 (Df).

Nephilengys cruentata, Simon, 1887: 271.

Nephilengys cruentata, Saaristo, 1978: 120, f. 211-223 (mf).

Nephilengys cruentata, Roberts, 1983: 284, f. 222-224 (m).

N.B. For more references see Platnick (2003).

Material examined: Aldabra, Picard, 1f, Dec. 2000, P. Matyot leg. (MZT AA 2.239); Conception, 2juvs., Febr. 2002, P. Matyot leg. (MZT AA 2.238) and 1m, 07.10.2002, J. Gerlach leg. (MZT AA 2.373); Mahé: various places, 4mm7ff, 27. & 30.10.1975, M. Saaristo leg. and 4f, Jan. 1999, M. Saaristo, P. Matyot and M. Kirkpatrick leg. (MZT AA 0.040, 0.532 and 0.533); Marianne, 1subad.f, Oct. 1999, P. Matyot leg. (MZT AA 2.225) and 1f, 21.03.2002 M. Hill leg. (MZT AA 2.338); Silhouette: several places, 2m, 1subad.m, 1f, 4subad.f, 1990 and Jan. 1999, M. Saaristo and J. Gerlach leg (MZT AA 0.234 and 0.235 and 0.534-0.538).

Diagnosis: The female of this large species (TL = ca.1.8mm) can be recognized by having 2 pairs of smallish, clear white spots on the other wise blackish venter of its abdomen that is somewhat elongated and angulate. Male like the female but much smaller and abdomen is covered by a dorsal scutum.

Description: The species has been well described by Saaristo (1978).

Distribution: This fairly large pantropical species has been found on the following islands: Aldabra (*), Conception (*), Curieuse (Benoit 1978b), Frégate (Benoit 1978b), Mahé (Simon 1898, Hirst 1911, Saaristo 1978), Marianne (*), Praslin (Hirst 1911) and Silhouette (Simon 1898, Hirst 1911, Benoit 1978b), and observed on Grande Soeur (J. Gerlach pers. comm.).

Remarks: Contrary to the previous species the female of *N. cruentata* is hiding in a ratger large, cup-like retreat near the top of the web. In the retreat there is also one or more males.

Subfamily Laucaucinae

Genus *Leucauge* White 1841

Discussion: This genus is once again an example of a vast basket containing a large number of species; according to Platnick (2003) 983 species. However, its type species, *Linyphia argyrobapta* White, 1841 from Brazil, has never been even adequately described. In fact, after its original description and its transference by Petrunkevitch (1911: 355) to *Leucauge*, it has appeared only in catalogues like Bonnet (1957), Roewer (1942) and Platnick (2003). The only exception is Levi (1980) who states: "The specimens of *L. argyrobapta* (White) are lost. The identity of the species is not known". Thus, at present, it is also impossible to diagnose the genus *Leucauge*. In spite of this several genera have been synonymized with *Leucauge* although it clearly remains as a *nomen dubium* until a neotype for *L. argyrobapta* has been selected and well described. While studying numerous representatives of *Leucauge* from the Old World I have come to the conclusion that several genera are involved and that certain old synonyms must be revalited and new ones are needed.

In the Seychelles three *Leucauge* species have been recorded. Two of them can be easily placed in existing genera, viz. *Tylorida* Simon, 1894 and *Mesida* Kulczynski, 1911.

On the other hand, the generic affinity of the third one is not clear. At the present stage of our knowledge of the old world Leucaucinae it seems preferable not to describe any new genera and it is here treated as a member of *Leucauge*.

***Leucauge argyrescens* Benoit, 1978. (Figs. 2-7)**

Leucauge argyrescens Benoit, 1978b: 671, f.3E-F (Df).

Leucauge russelsmithi Locket, 1980: 122, f. 15-25 (Dmf). **NEW SYNONYMY.**

Leucauge argyrescens, Locket 1980: 122, f. 26-28 (f).

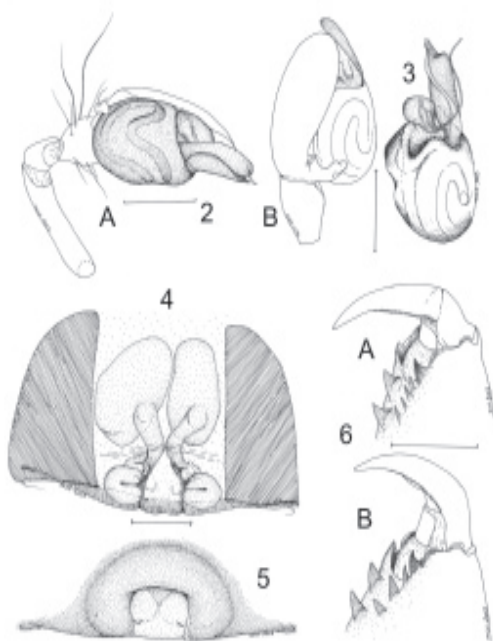
Material examined: Aride, 1juv., June 1999, J. Bowler leg. (MZT AA 1.296); Cousin, 2fl3j., 1978, H. Watkins leg. (MZT AA 0.241-0.244); Curieuse, sweeping., 3fl1juv., January 2000, Hill & Vel/ BLG leg. (MZT AA 1.796-1.798); Denis (# 149), sweeping., 8m29f45juvs., April 2000, Hill & Vel/ BLG leg. (MZT AA 1.781-1.790, 1.803-1.805); Felicite, sweeping., 10juvs., Nov. 1999, Hill & Vel/ BLG leg. (MZT AA 1.794-1.795); Mahé, La Reserve, 1m, 01.01.1999 and path between Le Niol and Mare aux Cochons, 3f, 02.01.1999, M. Saaristo, P. Matyot and M. Kirkpatrick leg. (MZT AA 0.521 and 0.522); Marianne, sweeping., 1f7juvs., 23.10. 1999, Hill & Vel/ BLG leg. (MZT AA 1.791-1.793, 2.082); North, sweeping., 2m3fl6juvs., May 1999, Hill & Vel/ BLG leg. (MZT AA 1.799-1.802); Silhouette, *Pisonia* forest (A15), 2f, 1990, J. Gerlach leg., Jardin Marron, 5f, 20.01.1999, Chemin Montagne Possee, 9f, Belle Vue, 4f, 18.01.1999 and La Passe, 4f, 19.01.1999 M. Saaristo and J. Gerlach leg. (AA 0.240 and 0.523-0.531).

Diagnosis: This rather small species (TL = 2.5–3.5mm) can be distinguished by the more or less globose abdomen having a blackish venter with 3 pairs small silvery spots. Abdomen dorsally two-coloured, anterior half pale, posterior one dark; both parts decorated with two pairs of silvery spots.

Description: Male (female well described by Benoit (1978b)) much like female but smaller and legs relatively longer. Segments of male palp not elongated. Cymbium unmodified. Paracymbium small, its apex slightly notched. Seminal duct inside tegulun rather thick, forming one large loop. Conductor relatively large, apical end of the embolar groove drawn out into a small pointed extension. Basal part of embolic complex bulbous, bearing a long, thread-like embolus.

Distribution: The species has been found on the following islands: Aride (*), Cousin (*), Curieuse (Saaristo & Hill 2002), Cousin (*), Felicite (Saaristo & Hill 2002), Mahé (Benoit 1978b and Saaristo 1999), Marianne (Saaristo & Hill 2002), North (Saaristo & Hill 2002), Praslin (Benoit 1978b) and Silhouette (Saaristo 1999).

Discussion: When describing a new *Leucauge* species, viz. *Leucauge russelsmithi* Locket, 1980 from the Comoro Islands he (Locket 1980) compared it with *L. argyrescens* of which only the female was known at that time. He (Locket 1980) found some differences between these two species such as sternum colouration, epigynum shape and dentation of the inner margin of the chelicera. However, both sternum colouration and epigynum shape of *L. argyrescens* are variable and two females from Cousin also had only three small teeth on the inner margin of their chelicerae, as in *L. russelsmithi*; in addition the male palps of these two species seems to be identical. On these grounds I consider *L. argyrescens* and *L. russelsmithi* to be conspecific.



Figs. 2-6. *Leucauge argyrescens* Benoit, 1978. – 2: Right male palp ectally (A) and dorsally (B). 3: Bulbus ventrally. – 4: Adnexae dorsally. 5: Epigyne ventrally. – 6: Apex of right chelicera of female from Silhouette (A) and Cousin (B). Scale bars = 0.2 mm. - Orig.

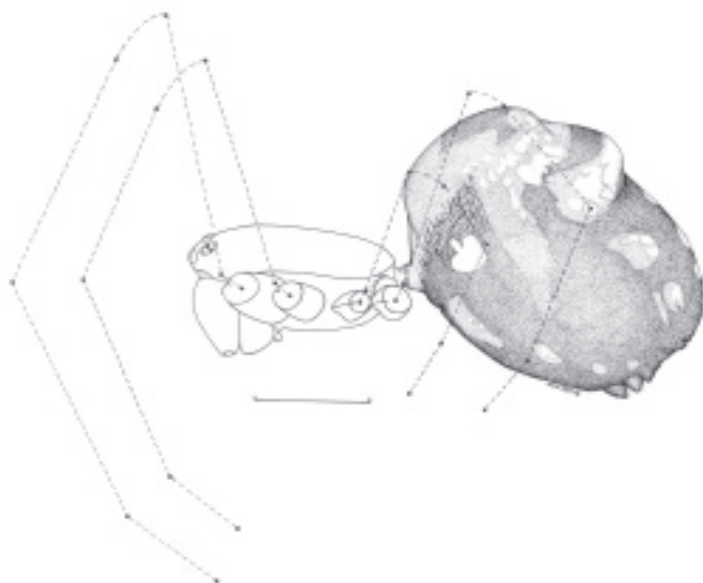


Fig. 7. *Leucauge argyrescens* Benoit, 1978. – Female sinistrolaterally. - Scale bar = 2.0 mm. - Orig.

Genus *Mesida* Kulczynski, 1911

Mesida thorellii (Blackwall, 1877) **n. comb.** (Figs. 8-14)

Tetragnatha thorellii Blackwall, 1877: 21, pl. 2, f. 15 (Df).

Argyropeira thorelli, Simon 1893: 278.

Leucauge thorelli, Benoit 1978b: 668, f. 3A-B (f,Dm).

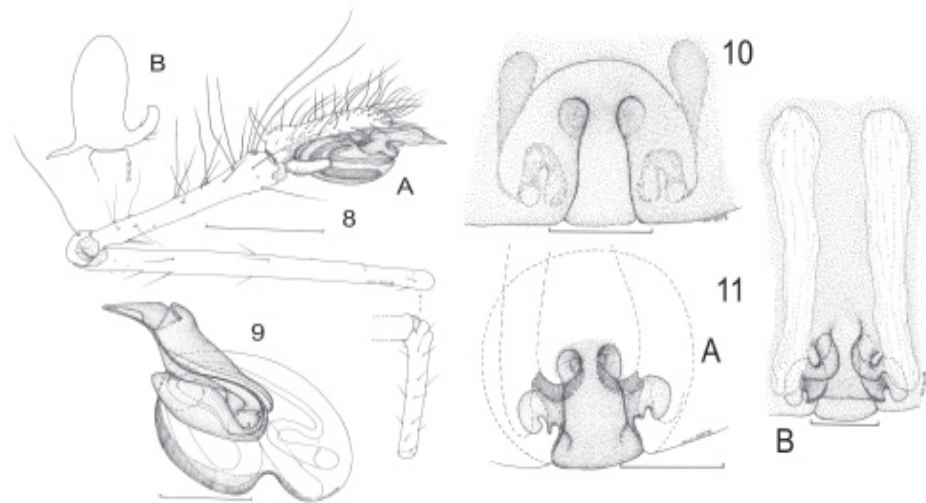
Material examined: La Digue, 1f, 20.10.2001, J. Gerlach leg. (MZT AA 2.287); Mahé, La Reserve, 1m3f, 01.01.1999 and path between Le Niol and Mare aux Cochons, 1f, 02/01/1999, M. Saaristo, P. Matyot and M. Kirkpatrick leg. (MZT AA 0.519 and 0.520), Silhouette: *Pisonia* forest, 3m2f1juv., 1990, La Passe, 3m5f 13.,15., and 19.01.1999, Belle Vue, 1m8f, 14.01.1999, Jardin Marron, 8f, 20.01.1999, and Chemin Montagne Possee, 10f, 12.01.1999, M. Saaristo and J. Gerlach leg. (MZT AA 0.236, 0.237, 0.506-0.518, and 1.032), Chemin Montagne Possee, sweep netting *Clidemia/ipomoea macrantha/ Asystasia*, 2m, 13.07.2000, J. Gerlach leg., M. Saaristo det. (MZT AA 1.354), peak beyond Mt. Corgat, *Gynura* sweep netting, 1m, 08.07.2000, J. Gerlach leg., M. Saaristo det. (MZT AA 1.355), and Jardin Marron, Malaise trap, 4m1f, Sept. 2000-Aug. 2001, R. & J. Gerlach leg. (MZT AA 2.259)

Diagnosis: This medium-sized (TL = 4-5mm) can be recognized by its elongated abdomen with silvery dorsum and characteristic dark posterior spots. Segments of male palp conspicuously elongated; cymbium with long, erect spine-like posterodorsal apophysis. Epigyne long and narrow; adnexae with a pair of long, narrow weakly sclerotized sacs.

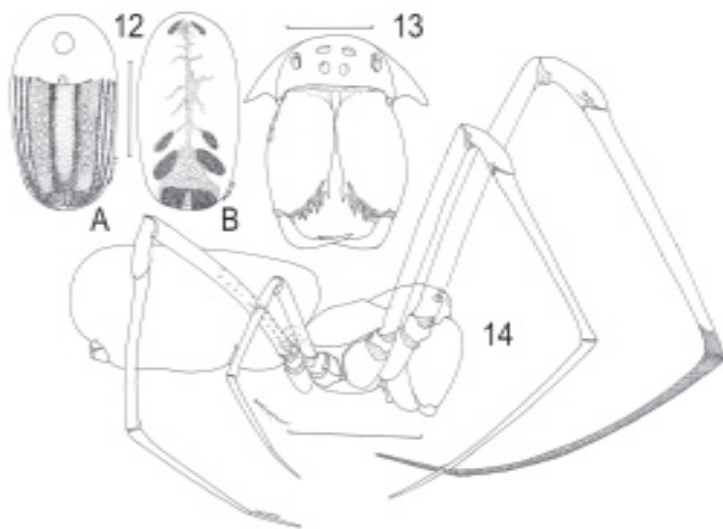
Description: The species has been well described by Benoit (1978b).

Distribution: This endemic species has been found on La Digue (*), Mahé (Simon 1893, Benoit 1978b, Saaristo 1999), Praslin (Benoit 1978b) and Silhouette (Benoit 1978b, Saaristo 1999).

Discussion: The species is here placed in *Mesida* as its secondary genitalia are similar to those of the type species of that genus, viz. *Mesida humilis* Kulczynski, 1911.



Figs. 8-11. *Mesida thorellii* (Blackwall, 1877) - 8: Right male palp ectally (A) and cymbium dorsally (B) - 9: Bulbus mesially - 10: Epigyne (type specimen) ventrally - 11: Adnexae ventrally (A) & dorsally (B) - Scale bars 8=0.5mm, 9=0.2mm, 10-11=0.2mm



Figs. 12-14. *Mesida thorellii* (Blackwall, 1877) - 12: Ventral (A) and dorsal (B) colour pattern of female abdomen - 13: Carapace and chelicerae of female frontally - 14: Female dextrolaterally – Scale bars; 12 = 1.2 mm, 13 = 1.0 mm, 14 = 2.0 mm. - Orig.

Genus *Tylorida* Simon, 1894

Tylorida mornensis (Benoit, 1978) **n. comb.** (Figs. 15-18)

Leucauge mornensis Benoit 1978b: 669, f. 3D-C (Dmf).

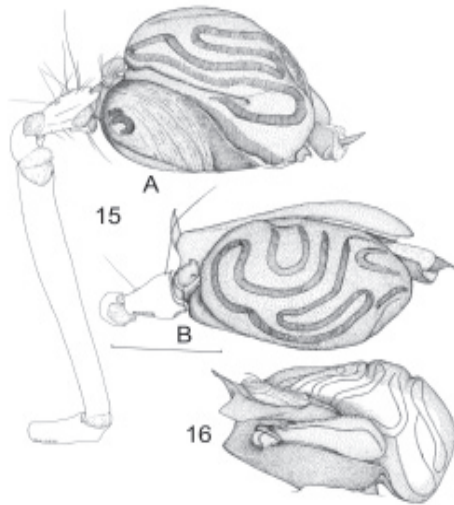
Material examined: Silhouette, *Pisonia* forest 4m4f2j., 1990, J. Gerlach leg. (MZT AA 0.238), Jardin Marron, 1m1f, 13.01.1999 and La Passe, 1subad.m2f 19.01.1999, M. Saaristo leg. (MZT AA 0.238, 0.239, 0.504, and 0.505), and *Pisonia* forest sweep netting, 1m2juv., 06.07. 2000, J. Gerlach leg., M. Saaristo det. (MZT AA 1.353).

Diagnosis: This is fairly large (TL = 5-7mm) dark coloured species. Abdomen globose, dorsally with dark, median saw-edged stripe, ventrally with a blackish hourglass-shaped figure. Tarsus of the male palp conspicuously elongated; cymbium with erect posterodorsal apophysis; seminal duct inside the prominent tegulum long and tortuous. Epigynal plate transverse oval, decorated by the transparent meandering tubes of adnexae.

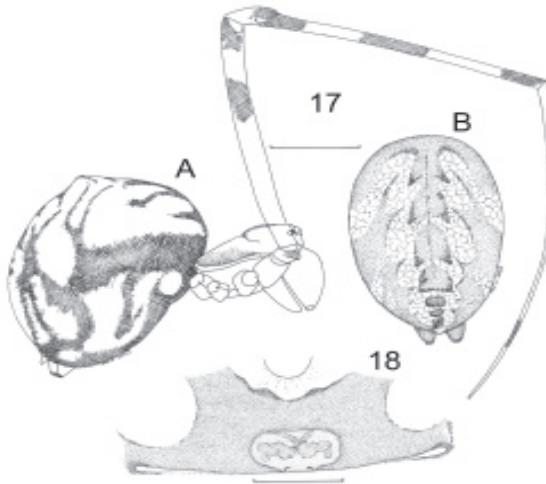
Description: The species has been well described by Benoit (1978b).

Distribution: At present it seems that *T. mornensis* may be endemic to Seychelles where it has been found on the following islands: Mahé (Benoit 1978b) and Silhouette (Saaristo 1999).

Discussion: The species was originally described in *Leucauge* but comparison with the type species of *Tylorida*, viz. *T. striata* (Thorell, 1877) revealed that the male and female secondary genital organs of the two species are almost identical. However, while *T. striata* is almost unicolourly yellowish with some silvery spots and black bands on legs *T. mornensis* is a much darker species. It is also almost twice the size of *T. striata*.



Figs. 15-16. *Tylorida mornensis* (Benoit, 1978). - 15 = Male palp ectally (A) and dorsally (B). - 16 = Bulbus ventrally. - Scale bar = 0.5 mm. - Orig



Figs. 17-18. *Tylorida mornensis* (Benoit, 1978). - 17: Female dextrolaterally (A), abdomen of dorsally (B). - 18: Epigyne ventrally. - Scale bars; 17=2.0mm, 18=0.5mm. - Orig.

subfamily Tetragnathinae

Remarks: The females of this subfamily have a much reduced epigyne consisting of only a very weakly sclerotized transverse plate which has openings leading to the adnexae on both sides. The abdominal area between this plate and the booklung openings is slightly elevated, forming a longitudinal ridge. Its length and width is more or less species specific. The adnexae consist of a large, very weakly chitinized median bag bearing well-sclerotized seminal receptaculæ on either side. Further along the dorsal side duct opens, this arises from an unpaired median bladder.

Genus *Dyschiriognatha* Simon, 1893

Dyschiriognatha argyrostilba (O. Pickard-Cambridge, 1876) (Figs. 19-20)

Pachygnatha argyrostilba O. Pickard-Cambridge, 1876: 573, pl. LIX, f. 8 (Dmf).

Dyschiriognatha argyrostilba, Simon 1893: 324.

Pachygnatha (Dyschiriognatha) argyrostilba, Pavesi 1895a: 504.

Dyschiriognatha atlantica Holm, 1969: 62, f. 1-5 (Dm).

Dyschiriognatha sanctahelenensis Holm, 1969: 62. **Nomen nudum.**

Dyschiriognatha atlantica, Benoit 1977: 160, f. 69a-e (m).

Dyschiriognatha argyrostilba, Bosmans & Bosselaers 1994: 346, f. 132-147 (mf = *atlantica*).

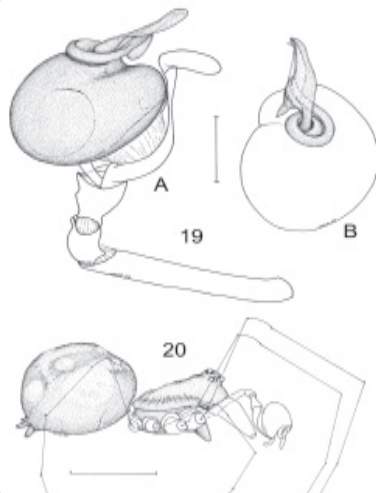
Material examined: Aride, 1m, 21.08.1975, J. Rowley leg. (MZT AA 0.245).

Diagnosis: This small (TL = 2-2.5mm) species with a spherical abdomen is easily recognized by having the tracheal spiracle positioned $\frac{1}{4}$ of the way from spinnerets to booklung spiracles.

Description: The species has been well described by Bosmans & Bosselaers (1994).

Distribution: According to Bosmans & Bosselaers (1994) the species is known from Egypt, Ethiopia, Cameroon, Zaire and St Helena island. In Seychelles the species has so far only been found on Aride (Bowler *et al.* 1999).

Discussion: *D. atlantica* was originally described from a single male specimen collected from St. Helena. It is evident that Holm (1969) aimed at first to describe the species under the name *Dyschiriognatha sanctahelenensis* as that name is used in a list of the *Dyschiriognatha* species from the Atlantic region just before the formal description of the species as *D. atlantica*! Accordingly *D. sanctahelenensis* must be considered as nomen nudum.



Figs. 19-20. *Dyschiriognatha argyrostilba* (O. Pickard-Cambridge, 1876) – 19: Right palp ectally (A), bulbus fontally (B) – 20: Male dextrolaterally – Scale bars; 19=0.2mm, 18=1.0mm. - Orig.

It should be noted that the very long, thin and hardly chitinized stylus of the embolus as figured by Holm (1969: Fig. 5) is an artefact (see also Bosmans & Bosselaers 1994: 347). In my specimen there is a similar structure, although it is much shorter. It is probably some kind of hardened seminal fluid pressed out of the embolus, probably due to the preserving liquid.

Genus *Tetragnatha* Latreillei, 1804

N.B. Allometric growth seems to affect both the form and size of the chelicera and its tooth.

Tetragnatha boydi O. Picard-Cambridge, 1898 (Figs. 21, 25)

Tetragnatha boydi O. Pickard-Cambridge, 1898: 389, pl. 31, f. 4 (Df).

Tetragnatha mandibulata, Saaristo 1978: 121, f. 224-231 (f, misidentification).

Tetragnatha infusca Benoit, 1978b: 667, f. 2D-E (Dm). **NEW SYNONYMY.**

Tetragnatha boydi, Okuma 1983: 70, f. 1A-L (mf); Okuma 1988b: 208, f. 20A-L (mf); Okuma & Dippenaar-Schoeman 1988: 223, f. 4A-L (mf); Okuma 1992: 221, f. 1A-L (mf).

Material examined: Mahé: Anse Louis, male holotype of *T. infusca*, 24.6.1972, P.L.G. Benoit & J.J. van Mol leg. (MRAC 143.319), mangrove thicket near the Reef Hotel, 1f2juvs., 24.10.1975, M. Saaristo leg. (MZT AA 0.041), and a brook near Mare aux Cochons, 1m2juvs., 02.01.1999, M. Saaristo, P. Matyot and M. Kirkpatrick leg. (MZT AA 0.497); North, hand collecting, 1m, May 1999, coll. BirdLife leg. (MZT AA 1.838); Silhouette, La Passe in association with *Nephila*, 2m5f, 10.01.1999, M. Saaristo & J. Gerlach leg. (MZT AA 0.496), mangrove, 1f, 15.01.1999, M. Saaristo & J. Gerlach leg. (MZT AA 0.498), near Dauban house, under *Casuarina* bark, 1f, 14.01.1999, M. Saaristo leg. (MZT AA 0.499), and 2f, Feb. 1993, J. Gerlach leg. (MZT AA 0.500).

Diagnosis: The male of this large (TL = 9-12mm), handsome *Tetragnatha* species can be recognized by the distinctive straight, flap-like apical part of the conductor and the female by the long, narrow epigyne; adnexae, which reach about half away of the length of the epigyne, with a pair of very small, spherical seminal receptaculæ. The female is further characterized by a small, basal cusp on the fangs.

Description: Well described e.g by Okuma & Dippenaar-Schoeman (1988).

Distribution: This is a wide spread species and found from Mexico to Brazil, Sardinia, Africa, and Nepal (Platnick 2003). In Seychelles it has been recorded from the following islands: Mahé (Saaristo 1978, 1999: *T. mandibulata*, Benoit 1978b: *T. mandibulata*), North (Saaristo & Hill 2002: *T. mandibulata*), Praslin (Hirst 1911: *T. mandibulata*, Benoit 1978b: *T. mandibulata*) and Silhouette (Saaristo 1999: *T. mandibulata*).

Tetragnatha ceylonica O. Pickard-Cambridge, 1869 (Figs. 22, 26)

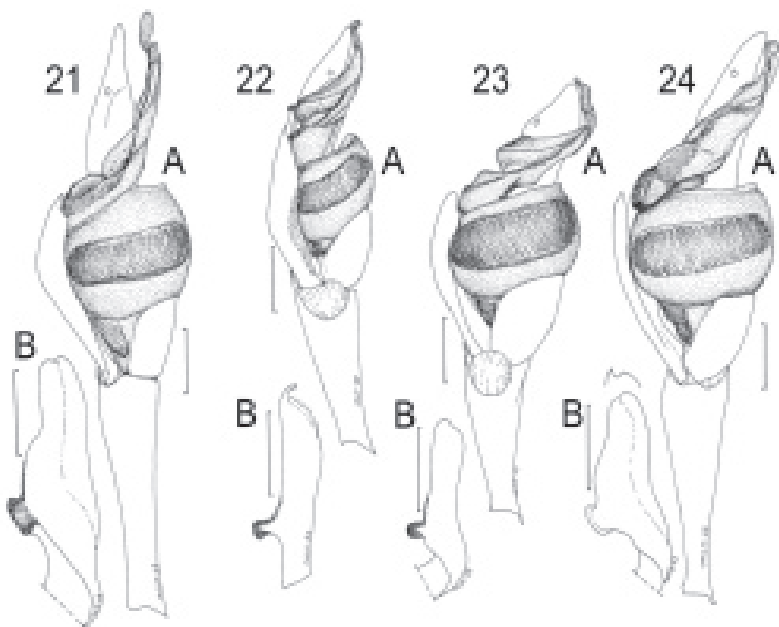
Tetragnatha ceylonica O. Pickard-Cambridge, 1869: 394, pl. 13, f. 83-88 (Dmf).

Tetragnatha modesta Hirst, 1911: 383, f. 2 (Df). **NEW SYNONYMY.**

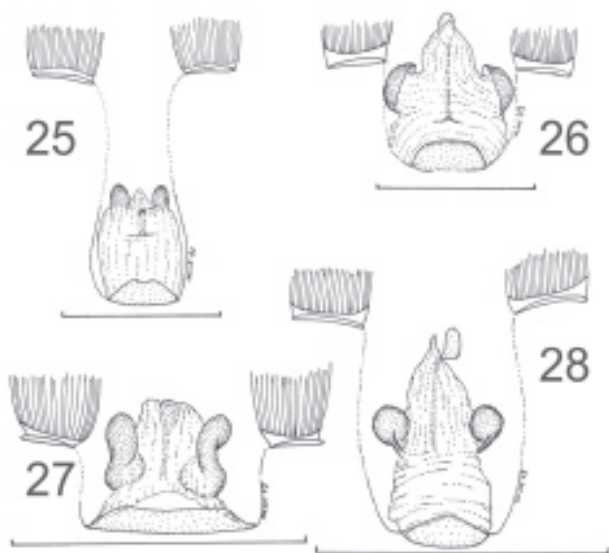
Tetragnatha modesta, Benoit 1978b: 666, f. 2A-C (mf).

Tetragnatha ceylonica, Okuma 1987: 48, f. 6A-I (mf); Okuma 1988a: 170, f. 3A-L (mf); Okuma & Dippenaar-Schoeman 1988: 227, f. 5A-L (mf); Barrion & Litsinger 1995: 513, f. 315a-g, 316a-m (mf); Song, Zhu & Chen 1999: 221, f. 125K, P-S (mf).

N.B. For more references see Platnick (2003).



Figs. 21-24. Male palp (A) and paracymbium (B). – 21: *Tetragnatha boydi* O. Pickard-Cambridge, 1898. – 22 = *T. ceylonica* O. P.-Cambridge, 1869. – 23: *T. demissa* L. Koch, 1872. – 24: *T. nigricularis* Simon, 1897. – Scale bars = 0.2 mm. - Orig.



Figs. 25-28. Adnexae of female. – 25: *Tetragnatha boydi* O. Pickard-Cambridge, 1898. – 26 = *T. ceylonica* O. P.-Cambridge, 1869. – 27: *T. demissa* L. Koch, 1872. – 28: *T. nigricularis* Simon, 1897. – Scale bars; 25 = 1.0 mm, 26-28 = 0.5 mm. - Orig.

Material examined: Mahé: Anse à la Mouche, 1m1f, 01.-15.07.1972, P.L.G. Benoit & J.J. van Mol leg. (MRAC 148.512); Silhouette, La Passe, in association with *Nephila*, 1m, 10.01.1999, M.Saaristo & J.Gerlach leg. (MZT AA 0.490), 1m1subad.m, 18.01.1999, J.Gerlach leg. (MZT AA 0.491) and mangrove, 1f, 15.01.1999, M.Saaristo & J.Gerlach leg. (MZT AA 0.492)

Diagnosis: The male is well distinguished by the apically hooked paracymbium and the hook-like apex of the conductor. The female epigyne is about as wide as long; adnexae, which reach behind the level openings of the booklungs, with a pair of cup-like seminal receptaculæ.

Description: Well described e.g by Okuma & Dippenaar-Schoeman (1988).

Distribution: South Africa, Sri Lanka to Philippines, New Britain (Platnick 2003). In Seychelles recorded from Mahé (Hirst 1911, Benoit 1978b as *T. modesta*) and Silhouette (Hirst 1911 and Saaristo 1999 as *T. modesta*).

***Tetragnatha demissa* L. Koch, 1872 (Figs. 23 27)**

Tetragnatha demissa L. Koch, 1872: 185, pl. 16, f. 1 (Df).

—, Keyserling, 1887: 221, pl. 20, f. 3 (Dm).

Tetragnatha foliifera Simon, 1898: 377 (Df). **NEW SYNONYMY.**

—, Hirst 1911: 381.

Tetragnatha quadridens Dondale, 1966: 1175, f. 4A-E (Dmf).

Tetragnatha foliifera, Benoit 1978b: 665, f. 1D (f).

Tetragnatha marginata, Saaristo 1978: 124, f. 232-241 (mf, missidentification; *S. T. quadridens* with *T. marginata* Thorell, rejected by Okuma 1987).

Tetragnatha demissa, Okuma 1987: 50, f. 7A-K (mf = *quadridens*).

Tetragnatha grenda Roberts, 1983: 247, f. 103-113 (Dmf). **NEW SYNONYMY.**

Tetragnatha demissa, Okuma & Dippenaar-Schoeman 1988: 227, f. 6A-M (mf)

Material examined: Aldabra, Picard, 1m1juv., Dec. 2000, P. Matyot leg. (MZT AA 2.242); Conception, sweeping, 1f1juv., Sept. 1999, coll. BirdLife leg. (MZT AA 1.610); Cousin, sweeping, 1f3juvs., March 2000, coll. BirdLife leg. (MZT AA 1.836) and sweeping, 5juvs., Dec. 1999, coll. BirdLife leg. (MZT AA 1.837); Cousine W-end “pedestal”, coconut leaves, 1f, 23.01.1999, M. Saaristo leg. (MZT AA 0.495); Mahé, yard of the Reef Hotel, from *Casuarina* bushes, 1m1f1juv., 24.10.1975, M. Saaristo leg. (MZT AA 0.042); Silhouette, La Passe, among leaves of bushes in front of Gerlachs, 1m, 15.01.1999, M. Saaristo leg. (MZT AA 0.493) and tortoise enclosures, 1m, 18.01.1999, J. Gerlach leg. (MZT AA 0.494); St. Francois, 1m1f2juvs., 08.04.2001, J. Gerlach leg. (MZT AA 2.204).

Diagnosis: The male of this species is well distinguished by the slightly S-like curved apex of the conductor. The female epigyne is distinctly wider than long; adnexae, which reach well behind the level openings of the booklungs, with a pair large, S-like curved seminal receptaculæ.

Description: Well described e.g by Okuma & Dippenaar-Schoeman (1988).

Distribution: South Africa, Australia to Tonga (Platnick 2003). In Seychelles recorded from Aldabra (*), Conception (*), Cousin (Saaristo & Hill 2002: *T. marginata*), Cousine (Saaristo 1999: *T. marginata*), Mahé (Hirst 1911: *T. foliifera*, Saaristo 1978: *T. marginata*, Benoit 1978b: *T. foliifera*), Silhouette (Simon 1898: *T. foliifera* Hirst 1911: *T. foliifera*, Saaristo 1999: *T. marginata*) and St. Francois (*).

***Tetragnatha nigricularis* Simon, 1898 (Figs. 24, 28)**

Tetragnatha nigricularis Simon, 1898: 377 (Df).

—, Benoit 1978b: 663, f. 1A-C (f,Dm).

Material examined: Mahé, Morne Séchellois, allotype male of *T. nigricularis*, 13.-17.7.1972, P.L.G. Benoit & J.J. van Mol leg. (MRAC 148.511) and a brook near Mare aux Cochons, 2m1f7juvs., 02.01.1999, M. Saaristo, P. Matyot and M. Kirkpatrick leg. (MZT AA 0.485); Silhouette, La Passe, among boulders of reservoir river, 3m11f2juvs., 19.01.1999, M. Saaristo leg. (MZT AA 0.483-0.484), boulders behind the dam, 5f3juvs., 15.01.1999, M. Saaristo leg. (MZT AA 0.486), and beating grass and bushes before the dam, 1f, 15.01.1999, M. Saaristo leg. (MZT AA 0.489), Jardin Marron, 2f, 20.01.1999, M. Saaristo leg. (MZT AA 0.487), and Belle Vue River (200 m elevation), 3f, 14.01.1999, M. Saaristo leg. (MZT AA 0.488).

Diagnosis: The male of this species is well distinguished by the small, flap-like laterally pointing apex of the conductor. The female epigyne is about twice as long as wide; adnexae, which reach about the level of the booklungs openings, with a pair spherical seminal receptaculæ.

Description: Well described by Benoit (1978b).

Distribution: This seems to be an endemic species found on the following islands: Curieuse (Benoit 1978b), Félicité (Hirst 1911), Mahé (Simon 1898, Hirst 1911, Benoit 1978b, Saaristo 1999), Praslin (Hirst 1911) and Silhouette (Hirst 1911, Saaristo 1999).

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Species list and relative abundance of marine molluscs collected on Aride Island beach between March 2001 and February 2002

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Abstract: A total of 261 mollusc species were found on Aride Island's beach during the study period. Of these, 224 were gastropods, 36 were bivalves and one was a cephalopod. Seven species, and a further seven specimens that could not be identified to species level, may constitute first records for the granitic Seychelles.

Key words: abundance, bivalve, gastropod, mollusc, Seychelles

Introduction

The original Aride Island marine mollusc species list, compiled by Jackson (1995), detailed the species of *Cypraea* and *Conus* collected by beachcombing on Aride's beach during the south-east monsoon season (June to September). The species list developed during this project details all mollusc species found on the beach during the period of study.

Methods

Specimens were collected during a daily thirty-minute walk along the beach at low tide during the period March 2001 to February 2002. Shell species were initially identified using Jarrett (2000). Samples that could not be identified to species level using the available literature were taken to the Natural History Museum, London, where they were identified using Abbott & Dance (1998), Lorenz & Hubert (1993), Röckel *et al.* (1995), Slimming & Jarrett (1970b) and Tursch & Greifeneder (2001), and through comparison with the reference collection. Specimens of all the species listed in this study are displayed in a reference collection housed on Aride.

To quantify the abundance of each species, it would be necessary to remove all specimens found on a daily basis. This was not done because of the large number of shells already on the beach and because of the ecological importance of shells to hermit crabs. Instead, for each species, all specimens found were removed from the beach and stored until the number of specimens reached 100, our highest relative abundance classification (Table 1). At this point, additional specimens were left on the beach and no further abundance data were recorded for the species. To minimise ecological impact, all 100 specimens were returned to the beach, except for specimens chosen for use the Aride reference collection. At the end of the study, all specimens not used in the reference collection were also returned to the beach.

By using this collection method, the relative abundance of each species could be estimated using the scale shown in Table 1. To allow comparison, the relative abundance descriptions were adapted from previous studies of *Cypraea* by Slimming & Jarrett (1970a) and Jackson (1995). As part of the adaptation, the two categories of 'Fairly common' and 'Quite common' were merged into scale 4 (Fairly common). To enable further comparison, the abundance descriptions in Jarrett (2000) were then adapted to the scale of relative abundance (Table 1). This adaptation is shown in Table 2.

Table 1 Scale used to record the relative abundance of shells beachcombed on Aride’s south beach over the period of study

Scale	Relative abundance	Number of specimens found during the period
1	Rare	1 to 4
2	Uncommon	5 to 8
3	Occasional	9 to 20
4	Fairly common	21 to 30
5	Common	31 to 99
6	Abundant	100 or more

Table 2 Classification of the descriptive text used by Jarrett (2000) into the scale of relative abundance used in this paper (detailed in Table 1)

Scale	Relative abundance	Corresponding descriptive terms
1	Rare	Very uncommon / Extremely uncommon / Most uncommon / Only one specimen found / Now hard to find
2	Uncommon	Rather uncommon / Uncommon / Common in only one locality
3	Occasional	Fairly uncommon / Moderately uncommon / Quite uncommon / Not uncommon / Not found very often / Infrequent
4	Fairly common	Fairly common / Moderately common / More common than an uncommon species / Fairly frequent
5	Common	Relatively common / Common / Occurs in large colonies / Collected in reasonable numbers
6	Abundant	Extremely common / Very common / Ubiquitous / Commonest / Particularly common/ Found almost everywhere / Large numbers on most reefs / More common than a common species
-	Unknown	Not stated in the descriptive text

Results

A total of 261 species of mollusc were collected over the study period. All species found are detailed in Appendix I. Of the 261 species, 224 were gastropods, 36 were bivalves and one was a cephalopod. Of the gastropods, there were 44 species of *Conus* and 36 species of *Cypraea*.

Appendix I also lists the relative abundance of each species, as calculated during this study, along with the relative abundance estimated by Jackson (1995), Jarrett (2000) and Slimming & Jarrett (1970a). Of the 261 species collected in this study, 99 were classified as scale 1 (Rare), 42 as scale 2 (Uncommon), 40 as scale 3 (Occasional), 24 as scale 4 (Fairly common), 31 as scale 5 (Common) and 25 as scale 6 (Abundant).

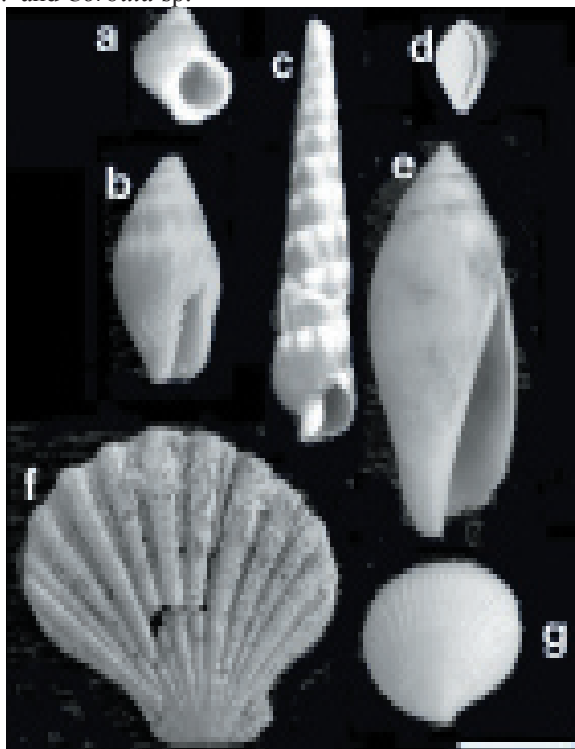
Since the study of beachcombed *Cypraea* on Aride (Jackson 1995), only two out of the 22 species originally recorded changed relative abundance by three scale places or more: *C. talpa* increased from scale 2 (Uncommon) to scale 5 (Common) and *C. nucleus* increased from scale 1 (Rare) to scale 6 (Abundant).

Slimming & Jarrett (1970a) described the overall abundance of *Cypraea* in the granitic Seychelles. This data was compared to the relative abundance measured in this study on Aride. *C. cicercula*, *C. globulus* and *C. nucleus* were more abundant by four scale places on Aride (scale 6, Abundant) than the granitic Seychelles as a whole (scale 2, Uncommon). Similarly, *C. clandestina* was more common by three scale places on Aride (scale 6, Abun-

dant) than overall in the granitic Seychelles (scale 3, Occasional). Only *C. tigris* was less abundant by more than two scale places on Aride than the granitic Seychelles as a whole: scale 3 (Occasional) versus scale 6 (Abundant) respectively. Two species, *C. helvola* and *C. histrio* were consistently scale 6 (Abundant) in all four studies (this study, Jackson 1995, Jarrett 2000 and Slimming & Jarrett 1970a).

In comparing the relative abundance ratings of this study with Jarrett (2000), 48 had the same values, 64 were within one scale place, 48 within two scale places and 34 within three scale places. 11 species in this study were found to be commoner by four scale places in Jarrett (2000), and three species listed as being scale 1 (Rare) in this study, were scale 6 (Abundant) in Jarrett (2000): *Strombus g. gibberulus*, *Drupa ricinus* and *Oliva sidelia* var. *volvaroides*. 53 species found in our study were either not in Jarrett (2000) or were in Jarrett (2000) but lacked an abundance description.

Overall, eight species that we found were absent from all literature relating to the granitic Seychelles (Fig. 1): *Turbo bruneus*, *Strombus terebellatus*, *Pseudocypraea (Diminovula) adamsonii*, *Mitra aurantia*, *Terebra montgomeryi*, *Excellichlamys spectabilis*, *Ctena bella* and *Conus retifer*. Although *C. retifer* is not referred to in existing literature, it has been recorded on Silhouette (J. Gerlach pers comm.). A further seven distinct species could not be identified to species level: *Melanella* sp., *Quoyula* sp., *Caducifer* sp., *Euplica* sp., *Vexillum* sp., *Crassostrea* sp. and *Corbula* sp.



Figs. 1 a - *Turbo bruneus*; b - *Mitra aurantia*; c - *Terebra montgomeryi* (damaged during growth); d - *Pseudocypraea adamsonii*; e - *Strombus terebellatus*; f - *Excellichlamys spectabilis*; g - *Ctena bella*. Scale: 4□5mm

Discussion

Since Jackson (1995), only two species of *Cypraea* have increased in relative abundance by three scale places or more. These changes may indicate population change, but could simply reflect short-term increases in the number of beachcombed shells caused by climatic conditions or life cycle influences.

Of the 261 species that we found, 183 were recorded during the first two months of this study (mid-March to mid-May). In comparison, over a two-month period from mid-February to mid-April, 104 shell species were collected by beachcombing on Cousine Island (Lawrence & Steyn 2001). Lawrence & Steyn do not provide a detailed methodology, so this may be a result of differences in the methodology of collection. However, it may have arisen because of a greater range of offshore habitats, the presence of certain food resources and/or the absence of certain predators in the waters surrounding Aride, compared to some of the islands nearer to the larger granitic Seychelles Islands.

Only three species that we classified as scale 1 (Rare) were scale 6 (Abundant) in Jarrett (2000); however, a further 11 species were four scale places higher in Jarrett (2000). It is likely that these species prefer habitats or niches that are more extensive, or are of better quality, at sites away from Aride. This may explain why Aride does not have many of the 649 species listed in Jarrett (2000) and why 14 of the species recently found on Cousine Island (Lawrence & Steyn 2001) were absent in this study.

Conversely, Jarrett (2000) states that he does not know of any sites where *Cypraea mauritiana* can be regularly found, yet we collected five specimens on the beach over the study period. Jarrett (2000) knows of only one specimen of *Conus cylindraceus* collected in the granitic Seychelles, but a second specimen was found during this study. Additionally, fifteen species that we found were not mentioned in Jarrett (2000). It should be noted that Jarrett (2000) is mostly based on observations on Mahe.

Several factors may influence our abundance comparisons; the abundance descriptions in Jarrett (2000) are purely subjective, with no quantified method described; the abundances in Jarrett (2000) refer to live, not beachcombed, specimens; greater abundances of living shells will be found in shallow rather than deep water due to ease of location; species that are smaller may be recorded as being less abundant because they are overlooked.

Additionally, it was apparent that the number and types of shell washed up depends on both the date and the sea conditions. A week of rough seas in June resulted in many larger species being washed up, whilst calmer conditions in August resulted in the deposition of many smaller species on the sand at the west end of the beach. Although the majority of the shells collected on Aride's beach are likely to be from the surrounding reef, it is likely that *Janthina janthina* and *Nautilus pompilius* are from deeper waters due to their pelagic lifestyles. It should be noted that it is possible that other smaller shells, such as *Trivia oryza* or *Mitra tabanula*, could have been washed up from further afield.

Despite these influencing factors, *Cypraea helvola* and *C. histrio* have been recorded as scale 6 (Abundant) in all four studies and, of the 208 species that we found with abundances detailed in Jarrett (2000), 48 have the same relative abundance rating as this study. In total, 54% of the species recorded in this study have either the same relative abundance rating or are within one abundance scale place, suggesting that the majority of abundance ratings are consistent throughout the granitic Seychelles.

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Appendix I: Species list and abundance of marine molluscs collected on Aride Island beach between March 2001 and February 2002. Species have been classified in the order that they are found in Hardy's Internet Guide to Marine Gastropods (Hardy 2002). Studies for relative abundance: 1 - Slimming & Jarrett (1970a); 2 - Jackson (1995); 3 - Jarrett (2000); 4 - this study

Class	Family	Species	Authority	Relative abundance			
				1	2	3	4
Gastropoda	Patellidae	<i>Cellana radiata</i>	(Born, 1778)	-	-	-	6
		<i>Diodora singaporensis</i>	(Reeve, 1855)	-	-	-	2
	Fissurellidae	<i>Fissurella (Montfortia) cumingii</i>	(Reeve, 1859)	-	-	-	1
		<i>Emarginula scutellata</i>	(Deshayes, 1863)	-	-	-	1
	Trochidaetrochinae		<i>Monodonta australis</i>	(Lamarck,			
			4	1			
	-	<i>Clanculus flosculus</i>	(Fisher, 1878)	-	-	5	2
		<i>Trochus maculatus</i>	(Linneaus, 1758)	-	-	5	4
	-	<i>Trochus mauritianus</i>	(Gmelin, 1791)	-	-	4	5
		<i>Trochus virgatus</i>	(Gmelin, 1791)	-	-	5	6
	-	<i>Stomatia phymotis</i>	(Helbling, 1779)	-	-	1	1

Class	Family	Species	Authority	Relative abundance			
				1	2	3	4
	Turbinidae	<i>Turbo argyrostomus</i> syn. <i>margaritaceus</i>	(Linnaeus, 1758)	-	-	5	6
		<i>Turbo bruneus</i>	(Röding, 1798)	-	-	-	1
		<i>Turbo marmoratus</i>	(Linnaeus, 1758)	-	-	2	1
		<i>Turbo petholatus</i>	(Linnaeus, 1758)	-	-	4	2
		<i>Turbo setosus</i>	(Gmelin, 1791)	-	-	5	6
		<i>Phasianella aethiopica</i>	(Philippi, 1853)	-	-	5	2
	Neritopsidae	<i>Neritopsis radula</i>	(Linnaeus, 1758)	-	-	1	3
	Neritidae	<i>Mienerita (Nerita) debilis</i>	(Dufo, 1840)	-	-	3	1
		<i>Nerita albicilla</i>	(Linnaeus, 1758)	-	-	5	6
		<i>Nerita plicata</i>	(Linnaeus, 1758)	-	-	5	5
		<i>Nerita polita</i>	(Linnaeus, 1758)	-	-	4	1
		<i>Nerita textilis</i>	(Gmelin, 1791)	-	-	4	5
	Cerithiidae	<i>Cerithium acutinodulosum</i>	Smith, 1884	-	-	4	1
		<i>Cerithium atomarginatum</i>	(Dautzenberg & Bouge, 1933)	-	-	2	
		<i>Cerithium echinatum</i>	(Lamarck, 1822)	-	-	5	5
		<i>Cerithium nodulosum</i>	(Bruguière, 1792)	-	-	-	3
		<i>Rhinoclavis sinensis</i> syn. <i>Obeliscus cedonulli</i>	(Gmelin, 1791)	-	-	4	1
	Planaxidae	<i>Planaxis niger</i>	(Quoy & Gaimard, 1834)	-	-	4	
	Modiolidae	<i>Modulus tectum</i>	(Gmelin, 1791)	-	-	2	1
	Littorinidae	<i>Littorina kraussi</i>	(Rosewater, 1970)	-	-	5	3
	Strombidae	<i>Lambis chiragra arthritica</i>	(Röding, 1798)	-	-	4	5
		<i>Lambis crocata crocata</i>	(Link, 1807)	-	-	4	4
		<i>Lambis truncata truncata</i>	(Humphrey, 1786)	-	-	4	4
		<i>Strombus aurisdianae</i>	(Linnaeus, 1758)	-	-	3	3
		<i>Strombus decorus decorus</i>	(Röding, 1798)	-	-	4	1
		<i>Strombus dentatus</i>	(Linnaeus, 1758)	-	-	1	3
		<i>Strombus erythrinus erythrinus</i>	(Dillwyn, 1817)	-	-	2	1
		<i>Strombus gibberulus gibberulus</i>	(Linnaeus, 1758)	-	-	6	1
		<i>Strombus lentiginosus</i>	(Linnaeus, 1758)	-	-	3	2
		<i>Strombus mutabilis</i>	(Swainson, 1821)	-	-	4	2
		<i>Strombus pipus</i> syn. <i>papilio</i>	(Röding, 1798)	-	-	2	1
		<i>Strombus sinuatus</i>	(Humphrey, 1786)	-	-	2	2
		<i>Strombus terebellatus</i>	(Sowerby, 1842)	-	-	-	1
	Hipponicidae	<i>Hipponix conica</i>	(Schumacher, 1817)	-	-	5	4
	Vanikoridae	<i>Vanikoro cancellata</i>	(Lamarck, 1822)	-	-	4	3
	Capulidae	<i>Malluvium lissus (Hipponix lissa)</i>	(Smith, 1894)	-	-	-	2
	Cypraeidae	<i>Cypraea annulus</i>	(Linnaeus, 1758)	6	6	6	5
		<i>Cypraea arabica</i> var. <i>immanis</i>	(Linnaeus, 1758)	3	1	3	3
		<i>Cypraea argus</i>	(Linnaeus, 1758)	2	-	2	4
		<i>Cypraea asellus</i>	(Linnaeus, 1758)	-	3	4	5
		<i>Cypraea caputserpentis</i>	(Linnaeus, 1758)	4	5	5	6
		<i>Cypraea carneola</i>	(Linnaeus, 1758)	5	6	6	5
		<i>Cypraea caurica</i>	(Linnaeus, 1758)	6	3	5	5
		<i>Cypraea cicercula</i>	(Linnaeus, 1758)	2	6	4	6
		<i>Cypraea clandestina</i>	(Linnaeus, 1767)	3	-	4	6
		<i>Cypraea cribraria</i>	(Linnaeus, 1758)	2	-	2	1
		<i>Cypraea depressa</i>	(Gray, 1824)	3	3	3	4
		<i>Cypraea diliculum</i>	(Reeve, 1845)	-	-	3	1
		<i>Cypraea erosa</i>	(Linnaeus, 1758)	4	2	5	4
		<i>Cypraea fimbriata</i>	(Gmelin, 1791)	4	-	6	4
		<i>Cypraea globulus</i>	(Linnaeus, 1758)	2	6	3	6
		<i>Cypraea helvola</i>	(Linnaeus, 1758)	6	6	6	6
		<i>Cypraea hirundo</i> var. <i>francisca</i>	(Linnaeus, 1758)	3	-	-	5
		<i>Cypraea histrio</i>	(Gmelin, 1791)	6	6	6	6
		<i>Cypraea isabella</i>	(Linnaeus, 1758)	4	4	4	6
		<i>Cypraea kieneri</i>	(Hidalgo, 1906)	3	-	-	2
		<i>Cypraea limacina</i>	(Lamarck, 1810)	3	-	2	1
		<i>Cypraea lynx</i>	(Linnaeus, 1758)	5	3	6	5
		<i>Cypraea mappa</i>	(Linnaeus, 1758)	1	1	1	2
		<i>Cypraea mauritiana</i>	(Linnaeus, 1758)	2	-	1	2
		<i>Cypraea moneta</i>	(Linnaeus, 1758)	5	6	6	6
		<i>Cypraea nucleus</i>	(Linnaeus, 1758)	2	1	6	6
		<i>Cypraea poraria</i>	(Linnaeus, 1758)	2	-	1	3
		<i>Cypraea punctata</i>	(Linnaeus, 1758)	3	-	4	4

Class	Family	Species	Authority	Relative abundance			
				1	2	3	4
		<i>Cypraea scurra</i>	(Gmelin, 1791)	3	4	6	5
		<i>Cypraea staphylaea</i>	(Linnaeus, 1758)	3	-	4	2
		<i>Cypraea stolidia</i>	(Linnaeus, 1758)	2	-	1	1
		<i>Cypraea talpa</i>	(Linnaeus, 1758)	3	2	4	5
		<i>Cypraea teres</i>	(Gmelin, 1791)	3	-	4	3
		<i>Cypraea testudinaria</i>	(Linnaeus, 1758)	2	1	3	2
		<i>Cypraea tigris</i>	(Linnaeus, 1758)	6	3	5	3
		<i>Cypraea vitellus</i>	(Linnaeus, 1758)	4	2	6	3
	Ovulidae	<i>Ovula ovum</i>	(Linnaeus, 1758)	-	-	1	3
	Pediculariidae	<i>Pseudocypraea (Diminovula) adamsonii</i>	(Sowerby, 1832)	-	-	-	1
	Triviidae	<i>Trivia oryza</i>	(Lamarck, 1810)	-	-	4	6
	Naticidae	<i>Polinices simiae</i>	(Deshayes, 1838)	-	-	3	1
		<i>Polinices tumidus</i>	(Swainson, 1840)	-	-	5	1
	Tonnidae	<i>Malea pomum</i>	(Linnaeus, 1758)	-	-	-	1
		<i>Tonna perdix</i>	(Linnaeus, 1758)	-	-	3	1
	Cassidae	<i>Cypraecassis rufa</i>	(Linnaeus, 1758)	-	-	4	1
		<i>Casmaria erinacea erinaceus</i> syn. <i>vibex</i>	(Linnaeus, 1758)	-	-	4	4
		<i>Phalium glaucum</i>	(Linnaeus, 1758)	-	-	2	1
	Ranellidae	<i>Gyrineum pusillum</i>	(Broderip, 1833)	-	-	4	1
		<i>Charonia tritonis</i>	(Linnaeus, 1758)	-	-	-	1
		<i>Cymatium aquatile</i>	(Reeve, 1844)	-	-	-	3
		<i>Cymatium hepaticum</i>	(Röding, 1798)	-	-	4	2
		<i>Cymatium nicobaricum</i>	(Röding, 1798)	-	-	6	3
	Personidae	<i>Distorsio anus</i>	(Linnaeus, 1758)	-	-	-	3
		<i>Distorsio reticulata</i>	(Linnaeus, 1758)	-	-	2	1
	Bursidae	<i>Bursa bufonia</i>	(Gmelin, 1791)	-	-	4	2
		<i>Bursa granularis</i>	(Röding, 1798)	-	-	4	3
		<i>Tutufa (Bursa) bubo</i>	(Linnaeus, 1758)	-	-	-	1
		<i>Tutufa (Bursa) rubeta</i>	(Linnaeus, 1758)	-	-	4	1
	Triphoridae	<i>Triphora crenulata</i>	(Deshayes, 1857)	-	-	-	1
		<i>Triphora rubra</i>	(Hinds, 1843)	-	-	4	1
	Janthinidae	<i>Janthina janthina</i>	(Linnaeus, 1758)	-	-	5	6
	Eulimidae	<i>Melanella</i> sp.		-	-	-	1
	Muricidae	<i>Chicoreus (Euphyllon) axicornis</i>	(Lamarck, 1822)	-	-	2	3
		<i>Chicoreus brunneus</i>	(Link, 1807)	-	-	5	1
		<i>Chicoreus ramosus</i>	(Linnaeus, 1758)	-	-	5	1
		<i>Chicoreus (Pterynotus) triqueter</i>	(Born, 1778)	-	-	1	3
		<i>Morula margariticola</i>	(Broderip, 1832)	-	-	5	2
		<i>Maculotriton seriale</i>	(Deshayes, 1834)	-	-	4	1
		<i>Drupa morum</i>	(Röding, 1798)	-	-	5	4
		<i>Drupa ricinus</i>	(Linnaeus, 1758)	-	-	6	1
		<i>Drupa rubusidaeus</i>	(Röding, 1798)	-	-	4	2
		<i>Drupella cornus</i>	(Röding, 1798)	-	-	-	5
		<i>Drupella rugosa</i>	(Born, 1778)	-	-	5	5
		<i>Drupina lobata</i>	(Blainville, 1832)	-	-	2	2
		<i>Morula biconica</i>	(Blainville, 1832)	-	-	1	3
		<i>Morula granulata</i>	(Duclos, 1832)	-	-	6	5
		<i>Morula uva</i>	(Röding, 1798)	-	-	4	6
		<i>Nassa francolina</i>	(Bruguière, 1789)	-	-	6	2
		<i>Purpura rudolphi (Thais rudolphi)</i>	(Lamarck, 1822)	-	-	-	5
		<i>Rapana rapiformis</i>	(Born, 1778)	-	-	4	1
		<i>Thais echinulata</i>	(Lamarck, 1822)	-	-	4	4
		<i>Thais mancinella</i>	(Linnaeus, 1758)	-	-	5	3
		<i>Thais tuberosa</i>	(Röding, 1798)	-	-	4	2

Class	Family	Species	Authority	Relative abundance			
				1	2	3	4
		<i>Coralliophila costularis</i>	(Lamarck, 1816)	-	-	2	1
		<i>Coralliophila erosa</i>	(Röding, 1798)	-	-	-	1
		<i>Coralliophila violacea</i>	(Kiener, 1836)	-	-	4	2
		<i>Quoyula</i> sp.		-	-	-	2
	Turbinellidae	<i>Vasum ceramicum</i>	(Linnaeus, 1758)	-	-	-	3
		<i>Vasum turbinellus</i>	(Linnaeus, 1758)	-	-	-	4
	Buccinidae	<i>Caducifer</i> sp.		-	-	-	1
		<i>Cantharus undosus</i>	(Linnaeus, 1758)	-	-	6	3
		<i>Colubraria nitidula</i>	(Sowerby, 1833)	-	-	4	1
		<i>Pisania decollata</i>	(Sowerby, 1833)	-	-	4	1
		<i>Pisania ignea</i>	(Gmelin, 1791)	-	-	4	2
	Colmbellidae	<i>Euplica</i> sp.		-	-	-	1
		<i>Pyrene (Columbella) turturina</i>	(Lamarck, 1822)	-	-	5	1
		<i>Mitrella albina</i>	(Kiener, 1841)	-	-	2	1
		<i>Pyrene flava</i>	(Bruguière, 1789)	-	-	5	1
		<i>Pyrene varians</i>	(Sowerby, 1832)	-	-	2	1
	Nassariidae	<i>Nassarius papillosus</i>	(Linnaeus, 1758)	-	-	4	2
		<i>Nassarius pauperus</i>	(Gould, 1850)	-	-	4	1
	Fasciolaridae	<i>Latirolagena smaragdula</i>	(Linnaeus, 1758)	-	-	5	2
		<i>Latirus craticulatus</i>	(Linnaeus, 1758)	-	-	4	3
		<i>Latirus polygonus</i>	(Linnaeus, 1758)	-	-	4	4
		<i>Peristernia nassatula</i>	(Lamarck, 1822)	-	-	5	3
		<i>Pleuroploca filamentosa</i>	(Röding, 1798)	-	-	4	3
		<i>Pleuroploca trapezium</i>	(Linnaeus, 1758)	-	-	5	5
	Olividae	<i>Oliva caerulea</i> syn. <i>episcopalis</i>	(Röding, 1798)	-	-	6	2
		<i>Oliva paxillus</i>	(Reeve, 1850)	-	-	3	1
		<i>Oliva sidelia</i> var. <i>volvaroides</i>	(Duclos, 1835)	-	-	6	1
		<i>Oliva miniacea tremulina</i>	(Lamarck, 1811)	-	-	5	3
	Harpidae	<i>Harpa amouretta</i>	(Röding, 1798)	-	-	4	4
		<i>Harpa major</i> syn. <i>ventricosa</i>	(Röding, 1798)	-	-	-	2
	Mitridae	<i>Mitra acuminata</i>	(Swainson, 1824)	-	-	2	1
		<i>Mitra aurantia</i>	(Gmelin, 1791)	-	-	-	1
		<i>Mitra cardinalis</i>	(Gmelin, 1791)	-	-	1	1
		<i>Mitra chrysostoma</i>	(Broderip, 1836)	-	-	1	1
		<i>Mitra cucumerina</i>	(Lamarck, 1811)	-	-	4	2
		<i>Mitra edentula</i>	(Swainson, 1823)	-	-	1	1
		<i>Mitra fastigium</i>	(Reeve, 1845)	-	-	4	3
		<i>Mitra ferruginea</i>	(Lamarck, 1811)	-	-	4	2
		<i>Mitra imperialis</i>	(Röding, 1798)	-	-	2	1
		<i>Mitra litterata</i>	(Lamarck, 1811)	-	-	4	4
		<i>Mitra tabanula</i>	(Lamarck, 1811)	-	-	1	1
	Costellariidae	<i>Vexillum</i> sp.		-	-	-	1
	Terebridae	<i>Terebra columellaris</i>	(Hinds, 1844)	-	-	2	1
		<i>Terebra crenulata</i>	(Linnaeus, 1758)	-	-	4	1
		<i>Terebra guttata</i>	(Röding, 1798)	-	-	3	1
		<i>Terebra maculata</i>	(Linnaeus, 1758)	-	-	4	2
		<i>Terebra montgomeryi</i>	(Burch, 1965)	-	-	-	1
	Conidae	<i>Conus abbas</i>	(Hwass, 1792)	-	-	1	1
		<i>Conus arenatus</i>	(Hwass, 1792)	-	-	6	2
		<i>Conus aulicus</i>	(Linnaeus, 1758)	-	-	2	5
		<i>Conus auricomus</i>	(Hwass, 1792)	-	-	1	1
		<i>Conus canonicus</i> syn. <i>tigrinus</i>	(Hwass, 1792)	-	-	6	4
		<i>Conus capitaneus</i>	(Linnaeus, 1758)	-	-	3	1
		<i>Conus catus</i>	(Hwass, 1792)	-	-	4	6

Class	Family	Species	Authority	Relative abundance			
				1	2	3	4
		<i>Conus chaldeus</i>	(Röding, 1798)	-	-	4	6
		<i>Conus coronatus</i>	(Gmelin, 1791)	-	-	6	6
		<i>Conus cylindraceus</i>	(Broderip & Sowerby, 1833)	-	-	1	1
		<i>Conus distans</i>	(Hwass, 1792)	-	-	4	2
		<i>Conus ebraeus</i>	(Linnaeus, 1758)	-	-	6	6
		<i>Conus episcopus</i>	(Hwass, 1792)	-	-	4	4
		<i>Conus flavidus</i>	(Lamarck, 1810)	-	-	4	3
		<i>Conus frigidus</i>	(Reeve, 1848)	-	-	3	5
		<i>Conus fulgetrum</i>	(Sowerby, 1834)	-	-	5	6
		<i>Conus geographus</i>	(Linnaeus, 1758)	-	-	4	5
		<i>Conus gubernator</i>	(Hwass, 1792)	-	-	3	2
		<i>Conus imperialis</i>	(Linnaeus, 1758)	-	-	4	4
		<i>Conus legatus</i>	(Lamarck, 1810)	-	-	1	1
		<i>Conus leopardus</i>	(Röding, 1798)	-	-	6	3
		<i>Conus litoglyphus</i>	(Hwass, 1792)	-	-	4	5
		<i>Conus litteratus</i>	(Linnaeus, 1758)	-	-	3	3
		<i>Conus lividus</i>	(Hwass, 1792)	-	-	6	6
		<i>Conus marmoreus forma bandanus</i>	(Linnaeus, 1758)	-	-	3	3
		<i>Conus miles</i>	(Linnaeus, 1758)	-	-	5	5
		<i>Conus mitratus</i>	(Hwass, 1792)	-	-	1	1
		<i>Conus moreleti</i>	(Crosse, 1858)	-	-	2	2
		<i>Conus musicus</i>	(Hwass, 1792)	-	-	-	6
		<i>Conus nussatella</i>	(Linnaeus, 1758)	-	-	4	4
		<i>Conus obscurus</i>	(Sowerby, 1833)	-	-	1	1
		<i>Conus pennaceus</i>	(Born, 1778)	-	-	2	1
		<i>Conus rattus</i>	(Hwass, 1792)	-	-	6	6
		<i>Conus retifer</i>	(Menke, 1829)	-	-	-	1
		<i>Conus sponsalis</i>	(Hwass, 1792)	-	-	4	5
		<i>Conus striatellus</i>	(Link, 1807)	-	-	1	1
		<i>Conus striatus</i>	(Linnaeus, 1758)	-	-	4	2
		<i>Conus tendineus</i>	(Hwass, 1792)	-	-	3	4
		<i>Conus tenuistriatus</i>	(Sowerby, 1858)	-	-	4	2
		<i>Conus tessulatus</i>	(Born, 1778)	-	-	-	1
		<i>Conus tulipa</i>	(Linnaeus, 1758)	-	-	2	5
		<i>Conus varius</i>	(Linnaeus, 1758)	-	-	4	1
		<i>Conus vexillum</i>	(Gmelin, 1791)	-	-	4	3
		<i>Conus virgo</i>	(Linnaeus, 1758)	-	-	-	3
	Architectonicidae	<i>Heliacus infundibuliformis</i>	(Gmelin, 1791)	-	-	1	1
		<i>Heliacus variegatus</i>	(Gmelin, 1791)	-	-	5	1
	Acteonidae	<i>Pupa nitidula</i>	(Lamarck, 1822)	-	-	1	1
	Siphonariidae	<i>Siphonaria atra</i>	(Quoy & Gaimard, 1833)	-	-	5	3
	Melampidae	<i>Melampus flavus</i>	(Gmelin, 1791)	-	-	5	2
Cephalopoda	Nautilidae	<i>Nautilus pompilius</i>	(Linnaeus, 1758)	-	-	-	1
Bivalvia	Arcidae	<i>Anadara antiquata</i>	(Linnaeus, 1758)	-	-	4	1
		<i>Arca avellana</i>	(Lamarck, 1819)	-	-	-	3
		<i>Barbatia fusca</i>	(Bruguière, 1789)	-	-	-	4
		<i>Barbatia helblingi</i>	(Bruguière, 1792)	-	-	5	2
		<i>Barbatia lacerata</i>	(Bruguière, 1792)	-	-	-	1
	Glycymerididae	<i>Glycymeris (Tucetona) tenuicostatus</i>	(Reeve, 1843)	-	-	-	2
	Mytilidae	<i>Brachidontes cf. variabilis</i>	(Krauss, 1848)	-	-	4	1
		<i>Modiolus auriculatus</i>	(Krauss, 1848)	-	-	-	5
		<i>Septifer bilocularis</i>	(Linnaeus, 1758)	-	-	-	1
	Pinnidae	<i>Atrina vexillum</i>	(Born, 1778)	-	-	2	1
	Pteriidae	<i>Pinctada margaritifera</i>	(Linnaeus, 1758)	-	-	2	5

Class	Family	Species	Authority	Relative abundance			
				1	2	3	4
	Isognomonidae	<i>Isognomon isognomum</i>	(Linnaeus, 1758)	-	-	-	1
	Pectinidae	<i>Chlamys senatorius</i>	(Gmelin, 1791)	-	-	-	1
		<i>Excelliochlamys spectabilis</i>	(Reeve, 1853)	-	-	-	1
		<i>Lyropecten (Decadopecten) noduliferus</i>	(Sowerby, 1842)	-	-	-	1
	Ostreidae	<i>Hyotissa hyotis</i>	(Linnaeus, 1758)	-	-	4	1
		<i>Hyotissa (Parahyotissa) numisma</i>	(Lamarck, 1819)	-	-	-	2
	Chamidae	<i>Chama brassica</i>	(Reeve, 1846)	-	-	-	3
		<i>Chama</i> sp.		-	-	2	3
	Lucinidae	<i>Codakia punctata</i>	(Linnaeus, 1758)	-	-	4	2
		<i>Codakia tigerina</i>	(Linnaeus, 1758)	-	-	4	2
		<i>Ctena bella</i>	(Conrad, 1837)	-	-	-	1
	Carditidae	<i>Cardita variegata</i>	(Bruguière, 1792)	-	-	5	4
	Crassatellidae	<i>Crassostrea</i> sp.		-	-	-	3
	Cardiidae	<i>Laevicardium biradiatum</i>	(Bruguière, 1792)	-	-	-	1
		<i>Trachicardium leucostomum</i>	(Born, 1778)	-	-	-	5
		<i>Trachicardium maculosum</i>	(Wood, 1815)	-	-	2	1
	Tridacnidae	<i>Tridacna maxima</i>	(Röding, 1798)	-	-	4	3
		<i>Tridacna squamosa</i>	(Lamarck, 1819)	-	-	4	4
	Donacidae	<i>Donax cuneatus</i>	(Linnaeus, 1758)	-	-	5	1
	Tellinidae	<i>Tellina scobinata</i>	(Linnaeus, 1758)	-	-	4	5
	Trapeziidae	<i>Trapezium oblongum</i>	(Linnaeus, 1758)	-	-	4	5
	Veneridae	<i>Australodosinai (Dosinia) histrio</i>	(Gmelin, 1791)	-	-	5	1
		<i>Periglypta puerpera</i>	(Linnaeus, 1771)	-	-	-	3
		<i>Periglypta reticulata</i>	(Linnaeus, 1758)	-	-	4	1
	Corbulidae	<i>Corbula</i> sp.		-	-	-	1

New terrestrial Gastropoda (Mollusca) from Seychelles

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Abstract: Thorough surveys of the terrestrial and freshwater mollusc fauna of the Seychelles islands have located all previously recorded species and a number of undescribed taxa. These are described here: *Moominia willii* (Pomatiopsidae), *Dupontia levensonia* (Helicarionidae), *Stylodonta unidentata sebertae*, *S. u. praslina* and *S. u. parva* (Acavidae), *Pachnodus ladiguensis* and *P. curiosus* (Cerastidae). *Moominia willii* is the first Pomatiopsidae from the western Indian Ocean region and is suggested to represent a Gondwana relict. The species is recorded from the axils of *Pandanus hornei* trees in mist forest. The two *Pachnodus* species are extinct and represented only by subfossil specimens.

Key words: *Dupontia*; *Moominia*; *Pachnodus*; Pomatiopsidae; *Stylodonta*

The terrestrial Mollusca of the Seychelles islands have been studied since 1838 (Dufo 1840) and are now the most well known group of invertebrates in the islands. The main focus of research has been on their taxonomy due to their interesting biogeographical affinities, showing a mixture of vicariant Gondwana origins, ancient and recent colonists (Gerlach & Bruggen 1999). Intensive field research by the author since 1986 has resulted in the collection of a large number of new taxa, this has been added to by the collections of the Indian Ocean Biodiversity Assessment 2000-2005. The recent collections have include a further four undescribed species and have prompted the revision of one variable species. The new taxa are described below. For each species IUCN Red List criteria are applied (IUCN 2001)

Abbreviations

AM Australian Museum

UMZC University Museum of Zoology, Cambridge

NPTS Nature Protection Trust of Seychelles

ZMB Zoological Museum, Berlin

PROSOBRANCHIA

Hydrobiidae

The hydrobioid Pomatiopsidae (Mollusca; Gastropoda) are widespread in tropical and temperate regions. Of the three subfamilies recorded, the Pomatiopsinae is the only one to include terrestrial and amphibious genera. Within the Pomatiopsinae the majority of genera are aquatic (*Cecina*, *Coxiella*, *Floridiscrobis*, *Fukuia*, *Idiopyrgus*, *Oncomyelania* and *Pomatiopsis*) with a single terrestrial genus, the arboreal *Blanfordia* of Japan.

In August 2000 5 specimens of an arboreal operculate snail were collected on Silhouette island. The species was immediately recognisable as distinct from any other Seychelles prosobranch genus by a number of external characters: a horny operculum (unlike *Tropidophora* and *Cyathopoma* - Pomatisidae), an undivided sole (unlike *Tropidophora* - Pomatisidae), the absence of accessory radular plates and a dextro-laterally placed penis

(unlike *Syncera* - Assimineidae). There are records of the superficially similar *Leptopoma* (Cyclophoridae), however this has 2 narrow, similar marginals. The two supposedly Seychelles *Leptopoma* (*L. seychellarum* Pfeiffer, 1874 and *L. seychellense*) have been suggested to be juveniles of *Tropidophora pulchra* (Martens 1898; Gerlach 1986) and this interpretation is probably correct. The specimens described below are the first pomatiopsid snails to be found in Seychelles and represent a new monotypic genus.

The only other hydrobioids to be recorded in the region have been Assiminaeidae (*Assiminea* and *Syncera* throughout the region, and *Omphalotropis* in the Mascarenes. The Assiminaeidae have multicusped lateral teeth and accessory radular plates and the penial opening is on the centre of the head, rather than the right side. The immature *Omphalotropis globosa* reported from Seychelles by Martens (1898) is described as having a strong keel around the umbilicus, a characteristic colour with “white spots and an interrupted serrated band on a dark chocolate-coloured base”, this does not resemble the species described below and its true identity remains unknown.

Genus *Moominia* gen. nov.

Type species: *Moominia willii* sp. nov.

Diagnosis: Arboreal pomatiopsid with conical shell. Body distinguished by a combination of long tentacles, well developed suprapedal fold and sessile eyes. Penis terminally dilated with elongate glandular papilla.

Etymology: *Moominia* in reference to the close resemblance of the body to the Moomins created in the books by Tove Jansson.

Distribution: Known only from Silhouette island, Seychelles.

Comparison with other pomatiopsine genera: *Moominia* differs from the arboreal *Blanfordia* of Japan which has stubby tentacles, in this genus eyes may be either sessile or tuberculate. Long tentacles are also found in *Pomatiopsis* (North America), *Coxiella* (Australia), *Floridiscrobis* (North America), *Idiopyrgus* (South America) and *Oncomyelania* (South and east Africa). Shell sculpture is indistinct on all genera except *Idiopyrgus* and *Oncomyelania*, both of which have a sculpture of pronounced radial ribs. The lack of gill filaments is shared with *Cecina* and the lack of papillae on the verge with *Cecina*, *Coxiella*, *Blanfordia*, *Fukina*, *Pomatiopsis* and *Tomichia*. *Moominia* differs from all other pomatiopsids in having a terminally expanded penis with a distinct glandular papilla. This resembles the penial structure of the Triculinae although it is distinct from this subfamily in moving by muscular action, possessing a suprapedal fold and in radular structure. The apparently triculinine penial structure may suggest that *Moominia* is a basal pomatiopsine, retaining some affinities to the triculines.

***Moominia willii* sp. nov. (Fig. 1)**

Type material: Holotype: UMZC 2000.33; Gratte Fesse, Silhouette island, Seychelles, 350m a.s.l. 21/7/2000, coll. J. Gerlach & J. Willi. Paratypes: NPTS 2000.20-3; Gratte Fesse, Silhouette island, Seychelles, 350m a.s.l. 21/7/2000, J. Gerlach & J. Willi.

Etymology: Named after Johanna Willi, collector of the first specimen

Description: Shell: Conical with 5 whorls. Apex blunt, protoconch of 1.5 smooth whorls. Raised ridge along keel and around columella, sculpture of semi-regular growth lines, separated by 2 fine regular radial ridges (10mm⁻¹). Columella angled at base; umbilicus open.

Operculum horny, transparent. Shell dark horn colour, translucent.

Body: Eyes sessile, tentacles long; suprapedal fold well developed; sole undivided. Body colour grey, a white glandular patch present behind each eye and on mantle posterior to border on left side. Mantle and mantle border grey, black band behind border.

Radula: Radula formula 1+2+C+2+1. Central tooth tricuspid, with 4 basal denticles. Marginals with 5 cusps, lateral with 10 comb-like cusps.

Reproductive anatomy: Penis elongate, penial sheath thick. Terminally expanded with elongate papilla. Papilla with distinct raised glands. 2 separate penial retractor muscles attached; the postero-lateral muscle joining the left optic retractor and the antero-medial muscle joining the right optic retractor.

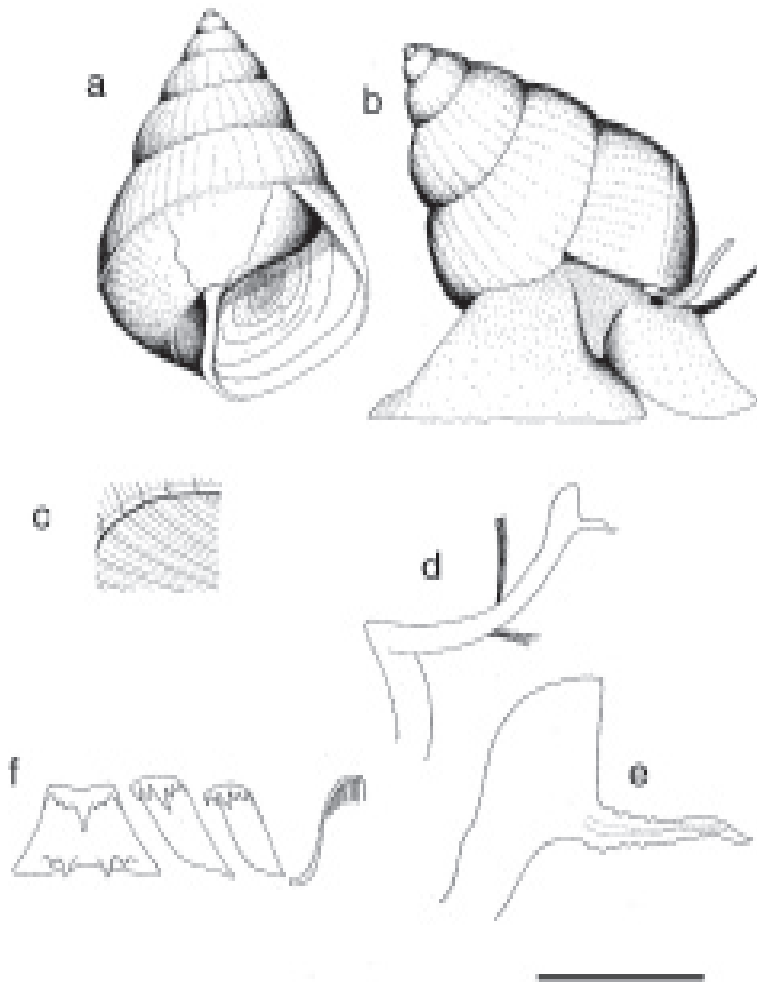


Figure 1. *Moominia willii* **a-b.** Holotype shell, scale bar: 1.2mm; **c.** Detail of shell sculpture of middle of body whorl, scale bar 0.3mm; **d.** Penis, scale bar 0.25mm; **e.** Detail of tip of penis, scale bar 0.05mm; **f.** Radula teeth C, 1, 2, 3, scale bar 0.03mm.

Table 1. *Moominia willii* measurements (in mm)

		Diameter	Height	Whorls	N
Holotype	(UMZ 2000.33)	4.8		3.4	5 -
Paratypes	(NPTS 2000.20)	4.5		3.4	5 -
	(NPTS 2000.21)	4.8		3.5	5 -
	(NPTS 2000.22)	2.5		1.6	3 -
	(NPTS 2000.23)	2.8		2.0	3 -
Range		2.5-4.8		1.6-3.5	3-5 5
Mean (s.d.)		3.9 (1.13)		2.8 (0.9)	4.2 (1.1)

Distribution: Gratte Fesse, Silhouette island, 350m a.s.l.. Collected from axils of *Pandanus hornei* trees. Searches of axils of *P. seychellarum* in similar habitats elsewhere on Silhouette have failed to locate the species. Habitat destruction on other Seychelles islands has eliminated most high-altitude populations of *P. hornei* (Gerlach 1997), it is possible that relict populations of arboreal pomatiopsids may be present on Mahé and Praslin islands and the family may have been more widely distributed in Seychelles in the past.

PULMONATA

Helicarionidae

Dupontia Godwin-Austen, 1908

The genus *Dupontia* was formed to include small discoidal Ereptinae (Helicarionidae), previously included in *Microcystis*. *Dupontia* was defined by Godwin-Austen (1908) as having a long body with small mantle lobes, but no shell lobes, a tail horn is present over a well developed mucus gland and the foot is divided. The shell is discoidal, with a low spire. The sculpture is reduced and the shell surface generally smooth. The radula has reduced cusps, bicuspid laterals. The Mascarene helicarionoid genera include *Calwellia*, *Ctenoglypta*, *Ctenophila*, *Dupontia*, *Erepta*, *Harmogenania*, *Lousisia*, *Pachystyla*, *Pilula*, *Plegma*, *Pseudocaelatura*, *Colparion*, *Macrochlamys* and *Thapsia*. *Dupontia* has 7 species in the Mascarenes: *D. laevis*, *D. maillardi*, *D. nitella*, *D. perlucida*, *D. poweri*, *D. virginia* and a newly described subfossil taxon (O. Griffiths, pers. comm.). All the extant species have been recorded on Mauritius, with *D. maillardi*, *D. nitella* and *D. virginia* also being present on Reunion. The subfossil taxon has been found on Rodrigues (O. Griffiths pers. comm.). To date no *Dupontia* species have been described outside of the Mascarenes although an unidentified species exists on Aldabra (Gerlach & Griffiths 2002).

In 1877 *D. virginia* was reported from Seychelles (Lienard, 1877; as '*Microcystis virginia*') but without a precise locality. The source of this record is not known and no specimens have been located, this record has therefore been considered to be an error (Gerlach 1986). In 2000 a *Dupontia* was collected on Silhouette island. Although the specimen has only 4 whorls and is probably not fully grown it is large enough to have developed distinctive sculpture and dissection revealed the presence of developed genitalia. Comparison with the Mascarene *Dupontia* show that the Seychelles taxon represents a distinct, undescribed species.

Dupontia levensonia sp. nov. (Fig. 2)

Type material: Holotype UMZC 2000.34, in axil of *Dracaena reflexa* plant, Mon Plaisir, Silhouette; mist forest 550m above sea level. 4/8/2000. J. Willi.

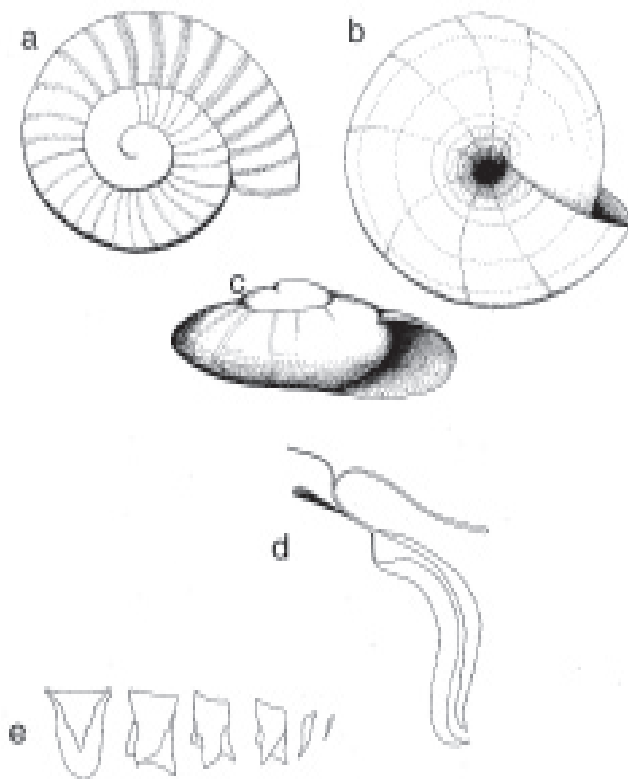


Fig. 2 *Dupontia levensonia* **a-c.** Holotype shell, scale bar: 0.5mm; **d.** Penis, scale bar 0.2mm; **e.** Radula teeth C, 1, 9, 10, 15, 21, scale bar 0.01mm.

Etymology: *levensonia* after Robert Levenson, supporter of conservation and research work on Silhouette and the Indian Ocean Biodiversity Assessment 2000-2005.

Description: Shell: The shell is discoidal, with a low spire. 2.5 whorls, with one smooth nuclear whorl. Sculpture of regular radial ridges, fine, regular spiral striae are visible at the edges of the ridges. Radial ridges reduced on underside but spiral striae are distinct and regular. The umbilicus is open but narrow (8% of shell diameter). Mouth broadly lunate. Horn coloured, glossy.

Body: The body has a caudal horn overhanging the caudal mucous gland. There is a distinct suprapedal groove. The body is dark grey.

Radula: Formula=31+9+C+9+31. Small lateral cusps are present on the marginal teeth. The laterals are unicuspid.

Reproductive anatomy: The penis is thin and elongate with a loosely attached penial sheath. The accessory organ is present as a swelling near the distal end of the penis, covered by the penial sheath. Epiphallus and flagellum are thin; penial retractor muscle terminal.

Table 2. *Dupontia levensonia* measurements (in mm)

	<u>Diameter</u>		<u>Height</u>	<u>Whorls</u>
UMZC 2000.34	1.0	0.6	2.5	

Distribution: Known only from the holotype from Mon Plaisir, Silhouette.
Notes: Conchologically the new taxon resembles *D. poweri* and *D. virginica* in the presence of spiral striae, although these are only visible at the sutures and not on the underside in *D. virginica*. Shell colour in *D. poweri* is greenish and reddish in *D. virginica*, unlike the horn colour of *D. levensonia*. Spiral striae have not been described in any other *Dupontia*.

Body colour is variable in the genus, with several brightly coloured species (yellow in *D. perlucida* and *D. nitella*). The black body found in *D. levensonia* is also recorded in *D. poweri* and *D. virginica*. Few of the previously described *Dupontia* species are known anatomically. In comparison to the new taxon *D. perlucida* has a longer penial accessory organ and epiphallus, and a radula formula of 39+9+C+9+39 (39+1+8+C+8+1+39 according to Godwin-Austen, 1908). In *D. laevis* there is no distinct penial accessory organ and the radula formula is 29+9+C+9+29 (26+4+8+C+8+4+26 according to Godwin-Austen 1908).

The anatomy of *Dupontia* species is too poorly known to allow discussion of the relationships between the species. *D. levensonia* represents a major range expansion for the genus and with the unidentified Aldabran *Dupontia* this suggests that the genus may be more widely distributed in the western Indian Ocean and more diverse than has previously been recognised. The small size of many of the species and the presence of taxa such as *D. levensonia* in under-studied micro-habitats such as palm, *Pandanus* and *Dracaena* axils may contribute to their having been overlooked on many islands.

Acavidae

The Acavidae are an example of Gondawanian distribution, being represented in South America, Africa, India, Sri Lanka, Australia and the Seychelles islands. These are all remnants of Gondwanaland and the current distribution is a result of continental drift. In Seychelles the family is represented by two species of the endemic genus *Stylodonta*, they are present on the granitic islands of Mahé, St. Anne, Silhouette, Praslin, Curieuse, Felicite (Nevill 1869 but not located subsequently) and La Digue. Considerable variation is found in shell morphology and several varieties have been reported in one species. New material allows the limits of subspecific variation to be determined.

Stylodonta unidentata (Holten, 1802) Fig. 4

<i>Helix unidentata</i>	Chemnitz 1795: 273; Holten 1802; Ferussac 1821: 104; Dufo 1840: 199; Pfeiffer 1841: 303; Reeve 1849: 156; Martens 1880: 256; Schacko in Möbius <i>et al.</i> 1880: 342; Pilsbry 1890: 85
<i>Helix (Stylodonta) unidentata</i>	Adams & Adams 1858; Nevill 1870: 63, 1878: 81
<i>Helix (Stylodon) unidentata</i>	Beck 1837
<i>Helix militaris</i>	Pfeiffer 1855: 111
44 <i>Helix (Stylodon) unidentata</i> var. <i>globata</i>	Martens & Wiegmann 1898: 19

Stylodonta unidentata

Sykes 1909: 62; Germain 1934: 123; Lionnet 1984:
241; Gerlach 1986:18

Stylodonta Studeri (partim)

Germain 1934: 123

Stylodonta Studeri var. *globata*, *militaris*

Germain 1934: 123

Stylodon studeriana (partim)

Edlinger 1988: 395

This species was first named by Chemnitz (1795) but this work was not consistently binomial and the name was first made available by Holten (1802). There is considerable geographical variation in shell proportions, radula formula and penis size. The anatomical variations could be regarded as being of subspecific level. The differences in measurements are all statistically significant at the $P < 0.0002$ level for height and diameter, although the proportions are not significantly different. Logarithmic regressions of height and diameter are significantly different for each population (Fig. 3, Table 4). These differences are not due to local ecophenotypic effects as is shown by captive breeding and rearing of the three Mahé forms under identical conditions; this still results in the characteristic shell morphology of each form.

Distribution: Mahé, St. Anne, Conception, Silhouette, Praslin, Curieuse, La Digue and Felicite. The records from Fregate (Germain 1934; Barnacle 1962; Lionnet 1984; Gerlach 1986) are in error for Felicite due to a transposition in Germain (1934). The specimens labeled 'Fregate' in the Barnacle collection in the BMNH are of unknown origin, they are exceptionally large and most closely resemble specimens from south Mahé.

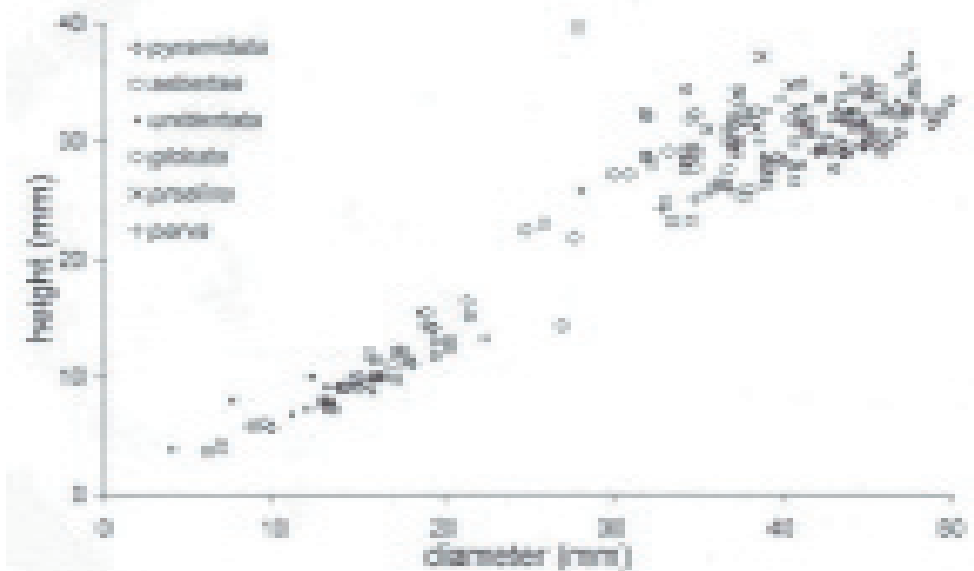


Fig. 3 Growth of *Stylodonta unidentata*

Table 3. *Stylodonta unidentata* measurements (in mm)

	Height	Diameter	H/D	N
South Mahé (La Reserve)	27.9-(31.35±2.21)-36.4	34.4-(44.58±3.18)-49.4	0.64-(0.71±0.06)-1.00	74
Central Mahé (Mt. Sebert)	23.2-(29.40±2.76)-34.4	31.9-(38.66±3.82)-44.6	0.67-(0.77±0.09)-1.02	33
North Mahé (Bernica)	28.1-(30.60±2.33)-33.6	37.5-(40.37±2.25)-43.8	0.68-(0.76±0.07)-0.84	25
St. Anne	28.8-(32.23±1.40)-37.4	38.7-(43.01±2.52)-47.5	0.71-(0.74±0.03)-0.78	27
Conception	31.8-34.4	41.2-49.1	0.70-0.77	2
Silhouette	27.2-(30.94±3.46)-39.7	25.0-(36.01±4.08)-40.5	0.72-(0.87±0.13)-1.42	123
Praslin	28.2-(33.41±2.68)-37.2	32.0-(39.80±2.83)-42.3	0.80-(0.84±0.05)-0.96	13
Curieuse	27.5	36.5	0.75	1
La Digue	24.3-(26.10±2.33)-31.1	33.0-(35.63±1.54)-37.5	0.70-(0.74±0.05)-0.84	8
‘Fregate’ (Barnacle colln.)	35-37	55-56	0.64-0.66	2

Table 4. Regression equations for *Stylodonta unidentata* populations, in all $P < 0.001$.

Island	Population	Regression	R ²
Mahé	Bernica	$\log(D+1) = 0.9871(\log[H+1]) - 0.1167$	0.945
Mahé	Mt. Sebert	$\log(D+1) = 1.0491(\log[H+1]) - 0.2019$	0.904
Mahé	La Reserve	$\log(D+1) = 1.0671(\log[H+1]) - 0.2614$	0.976
St. Anne		$\log(D+1) = 0.6587(\log[H+1]) + 0.4425$	0.489
Silhouette		$\log(D+1) = 1.1756(\log[H+1]) - 0.3458$	0.933
Praslin		$\log(D+1) = 0.7858(\log[H+1]) + 0.2783$	0.557
La Digue		$\log(D+1) = 1.3758(\log[H+1]) - 0.7146$	0.496

***Stylodonta u. unidentata* (Holten, 1802)**

Type material: Neither Chemnitz (1795) nor Holten (1802) designated a holotype. Chemnitz’s specimen cannot be located and a neotype is hereby designated: UMZC 2003.57.5 (Morne Blanc, Mahé; 24.vii.1996, J. Gerlach). This has the proportions of the Chemnitz (1795) figure and only the St. Anne - north Mahe populaiton would have been accessible in the 1790s (Chemnitz gave the erroneous locality ‘Cayenne’).

Description: Shell: Globular (H/D approximately 0.76) shell with 5-6 whorls, apex blunt, umbilicus covered. Slightly keeled in most (64%) specimens. Surface with fine regular spiral striae on first 2 whorls, others with irregular growth lines only. Mouth edge, thickened and reflected, violet colored, the outer edge white; a strong denticle on the columella. Shell colour yellow brown to dark brown (dark in 80% of specimens).

Body: Brown, shade varying with shell shade.

Radula: 10x4mm, 155 rows, 42+21+1+21+42; central tooth symmetrical, monocuspid, laterals bicuspid; marginals reduced.

Reproductive anatomy: Penis long (18mm), simple, retractor muscle sub-terminal. Thick penis sheath present. Spermatheca oval (1/4 penis length), duct long (slightly longer than penis), base of spermoviduct inflated into a brood chamber.

Distribution: North Mahé, St. Anne (extinct) and Conception. Widespread on Mahé but scarce since the introduction of the tenrec *Tenrec ecaudatus* in the 1890s; extinct on St. Anne following habitat destruction in the late 1700s. Vulnerable (D2 – geographically restricted).

***Stylodonta unidentata sebertae* ssp. nov.**

Type material: Holotype UMZC 2003.57.2, 5 paratypes NPTS M1997.208a (Mt. Sebert, Mahé, 5.i.1989. coll. J. Gerlach).

Etymology: Named after the type locality, Mt. Sebert.

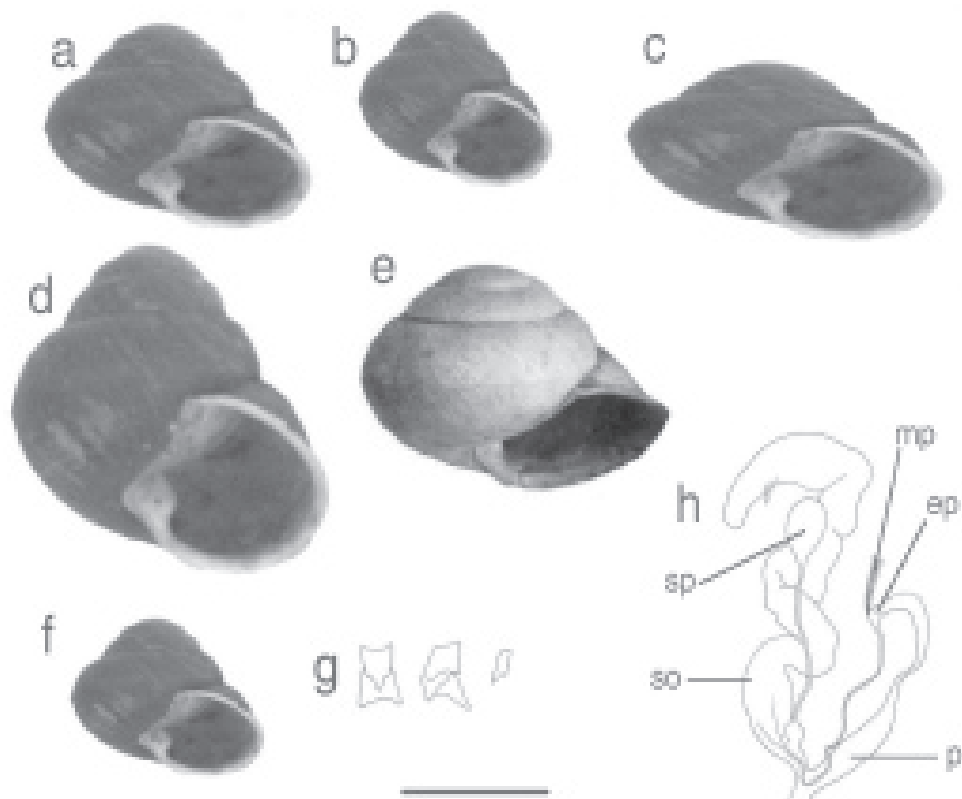


Fig. 4 *S. unidentata* subspecies. a- *S. u. unidentata*; b - *S. u. sebertae*; c - *S. u. pyramidata*; d - *S. u. globata*; e - *S. u. praslina*; f - *S. u. parva*; g - radula teeth (c, 1, 20); h - *S. u. unidentata* reproductive anatomy (ep - epiphallus, mp - penial retractor muscle, p - penis, so - spermoviduct, sp - spermatheca). Scale a-f=10mm, g=0.2mm, h=15mm

Description: Shell: A relatively small, globular form ($H/D=0.77$). Rarely keeled. Shell colour dark brown. Otherwise as type subspecies.

Anatomy: As type form except radula with 18 marginals

Distribution: West Mahé: Mt. Sebert, Cascade and Capucins. This subspecies is locally abundant, although it has declined at Cascade in recent years due to habitat loss and development. It was locally abundant in a small area at Mt. Sebert until the late 1990s but is now scarce, apparently as a result of habitat degradation. Vulnerable (D2 – geographically restricted).

***Stylodonta unidentata pyramidata* (Pfeiffer, 1841)**

Type material: Holotype not located; neotype designated UMZC 2003.57.6 (La Reserve, Mahé, 23.iii.1993. . J. Gerlach).

Etymology: Named after the type locality, La Reserve.

Description: Shell: A broad form ($H/D=0.71$), often slightly keeled (94% on Mahé).

Colour yellow brown to dark brown (dark in 55% of Mahé specimens). Otherwise as type subspecies.

Anatomy: Penis relatively long, with epiphallus present and more inflated than type form, radula as type form.

Distribution: South Mahé: a highly abundant subspecies at La Reserve. Vulnerable (D2 – geographically restricted).

Notes: – The type of *Helix unidentata* var. *pyramidata* is lost but the measurements fit those of the south Mahé population.

***Stylodonta unidentata globata* (Martens, 1880)**

Type material: Holotype ZMB 103.089; catalogued as Silhouette, 1895, A. Brauer (M. Glaubrecht pers. comm.). Named by Martens in 1880 in a figure caption but not described and no holotype designated until 1898□6.

Description: Shell. – Proportionately high ($H/D=0.87$); not keeled; shell almost always dark brown. Otherwise as type subspecies.

Anatomy: As type form except radula with reduced lateral teeth: 30+21+1+21+30.

Distribution: Silhouette. Vulnerable (D2 – geographically restricted).

Notes: A highly abundant subspecies all over Silhouette. Nevill (1878) reported the same variety occurring on Silhouette, Felicite and Curieuse, this would seem unlikely on biogeographical grounds (see the following taxon).

***Stylodonta unidentata praslina* ssp. nov.**

Type material: Holotype UMZC 2003.57.3; Paratype NPTS M2003.1 all Praslin National Park, Praslin, 18.iii.2002. J. Gerlach.

Etymology: Named after the island of origin, Praslin.

Description: Shell. High and proportionately narrow ($H/D=0.84$); not keeled. Otherwise as type subspecies.

Anatomy: As type form but penis not constricted, epiphallus not inflated. Additional lateral teeth: radula formula 52+21+1+21+52

Distribution: Praslin and Curieuse. Now extinct on Curieuse due to fires in the 1800s and extremely rare and localized on Praslin. Abundant subfossils in the north of Praslin indicate a wider historical distribution. Prior to of the loss of most of the island's forests in fires in the 1800s and predation by tenrecs (*Tenrec ecaudatus*). Vulnerable (D1 – population approximately 700 adults).

***Stylodonta unidentata parva* ssp. nov.**

Type material: Holotype UMZC 2003.57.4; paratype NPTS M2003.2, all Belle Vue, La Digue, Seychelles. vii.1990. O. Griffiths.

Etymology: *parva*, Latin for small.

Description: Shell. A relatively small shell with $H/D=0.74$; not keeled; always dark brown. Otherwise as type subspecies.

Anatomy: Unknown

Distribution: La Digue. Scarce, found only in the highest forest areas, historically probably more common and widespread as indicated by subfossils. Vulnerable (D2 – geographically restricted).

Cerastidae

The granitic Seychelles Cerastidae (until recently often placed in Enidae) comprise one endemic genus: *Pachnodus*. Two undescribed subfossil taxa have been collected.

***Pachnodus (Nesiocerastus) ladiguensis* sp. nov. (Fig. 5a)**

Pachnodus sp.

Griffiths & Gerlach 1991; 7

Pachnodus 'La Digue'

Gerlach 1997: 45, 1999: 252

Type material: Holotype (AMS C426122), 1 paratype (AMS C426123) - in sandy trenches, just N of Flycatcher Reserve, Anse La Reunion, La Digue; iv.2001, O.L. Griffiths; 1 paratype (NPTS M1999.3) – iii.1992; J. Gerlach. Additional non-type sepecimens in NTS and O. Griffiths collections, same locality as types.

Etymology: Named after the island of origin, La Digue.

Description: Shell: Shell conical with 6-6.25 whorls and 1 nuclear whorl, strong; surface shiny; irregular radial ridges, no spiral striae detectable. Suture with a slight ridge. Apex blunt; umbilicus open (1-1.8mm wide), partially covered by the columella; mouth edge slightly reflexed but not forming a true lip. Coloration originally mahogany brown with a dark spiral band on the middle of the body whorl and a pink tint to the columella. Most specimens are bleached and it is not known if the spiral band and the pink columella were normal characters.

Body and anatomy: Unknown.

Distribution: La Digue, Seychelles; only sub-fossil material from the plateau at La Reunion.

Notes: This species is most similar to *P. praslinus* and *P. fregatensis* but is distinguished by the presence of a slight sutural ridge. *P. praslinus* has a broader aperture.

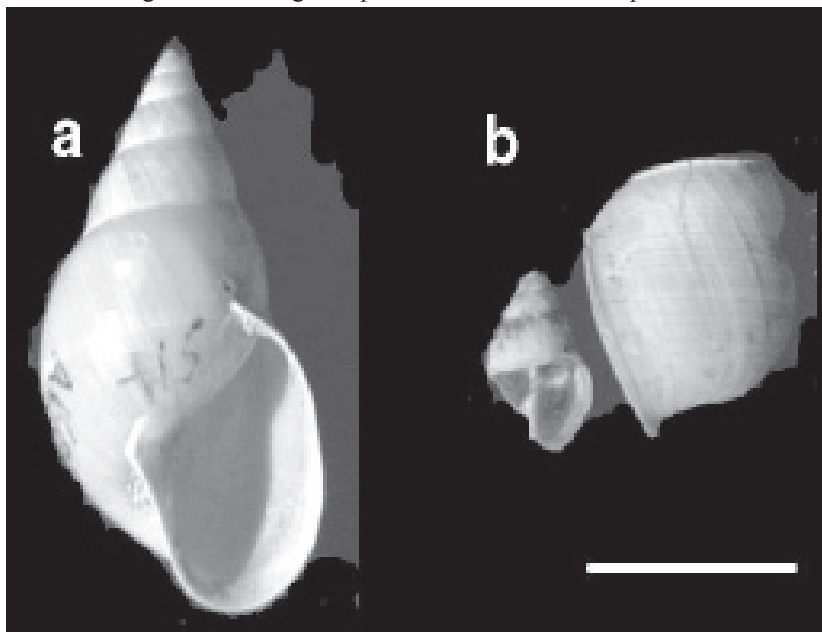


Fig. 5 a). *Pachnodus ladiguensis*; b). *Pachnodus curiosus*. Scale bar 15mm

The material consists of subfossil shells and fragments. No traces of recent shells or live specimens have been found on La Digue despite repeated searching, the species is therefore believed to be extinct. The subfossils were collected from spoil heaps and from ditches dug on the plateau. They were found in association with *Subulina octona*, *Paropeas achatinaceum*, *Caeciloides mauritiana*, *Stylodonta unidentata* and *Tropidophora pulchra*. Specimens found *in situ* were 15cm below the surface. The widespread alien species *Achatina fulica* was restricted to the top 10cm of soil. This species was introduced to Seychelles in the early 1800s (Dufo 1840), indicating that *P. ladiguensis* became extinct shortly after the island was colonized in the late 18th to early 19th century. The abundance of shells of species now rare on La Digue (*T. pulchra* and *S. unidentata*) in these deposits suggests that these species have declined due to human disturbance, probably forest clearance.

***Pachnodus (Nesiocerastus) curiosus* sp. nov.** (Fig. 5b)

Type material: Holotype (UMZC 2003.57.1), 3 paratypes (NPTSxxxxx), all fragmentary subfossils. Holotype from Baie Laraie, paratypes from Anse St. Joseph, all Curieuse 18.x.2002 (coll. J. Gerlach).

Etymology: Named after the island of origin, Curieuse.

Description: Shell: Shell conical; number of whorls estimated at 6; 2 nuclear whorls; thin and fragile; surface shiny; irregular radial ridges, well developed spiral striae. Suture with a slight ridge. Apex pointed; umbilicus probably open; mouth edge slightly reflexed but not forming a true lip. Coloration not known (all specimens are bleached).

Body and anatomy. - Unknown.

Distribution: Curieuse, Seychelles. Known only from sub-fossil material.

Notes: The limited available material of this species is most similar to *P. ladiguensis* and *P. fregatensis* but is distinguished by traces of a shiny shell surface in one specimen and in the size of the protoconch. These features resemble *P. oxoniensis*, *P. ornatus* and *P. kantilali* but differ from these species in the development of the suture and the mouth edge and the presence of a slight sutural ridge. *P. praslinus* has a broader aperture. On the basis of these comparisons *P. curiosus* appears to belong to the plesiomorphic terrestrial *Pachnodus* species (*P. fregatensis* and *P. ladiguensis* – Gerlach 1999).

The material consists of subfossil shell fragments. No traces of recent shells or live specimens have been found on Curieuse despite repeated searching, the species is therefore believed to be extinct. The subfossils were collected from plateau soil in association with *Stylodonta unidentata*, *S. studeriana* and *Tropidophora pulchra*. These have all been extinct on Curieuse since the early 1800s, probably as a result of extensive forest fires.

Table 6. *Pachnodus ladiguensis* measurements (in mm) (n = 6)

	Height	Diameter	H/D	Whorls
Holotype (AMS C426122)	26.8	14.6	1.84	6.25
Paratype (AMS C426123)	26.0	14.8	1.76	6
Paratype (NPTS M1999.3)	23.5	11.8	1.99	6
Range, mean and s.d.	23.5-(26.10±1.53)-28.0	11.8-(13.93±1.11)-14.8	1.75-(1.88±0.11)-2.00	6-6.25

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The relationships between length and weight of the Aldabra giant tortoise, *Dipsochelys dussumieri*, in Mauritius

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Abstract: In the Republic of Mauritius Aldabra giant tortoises, *Dipsochelys dussumieri* (also known as *Geochelone gigantea*), are kept in captivity mainly in private parks, public gardens, a few sugar estates and by some people as pets. The study was carried out in two private parks: Casela and La Vanille and two public gardens, SSR Botanical Garden at Pamplemousses and Balfour Garden. The private parks were better managed and maintained by virtue of their commercial purpose. Improvements were needed for Balfour Garden. Regressions were established between straight, curved carapace lengths and weight of juveniles, adults, both males and females. Regressions for adult males and females were compared using two different methods (straight and curved carapace lengths). A strong positive relationship was observed between the weight and straight carapace length of juveniles ($R^2=0.96$) and adult males ($R^2=0.88$), whereas, for adult females there was a weaker relationship ($R^2=0.69$). The same coefficient of regression was observed when the curved carapace length was regressed with weights for juveniles. A strong positive relationship was observed between weight and curved carapace length of adult males ($R^2=0.94$), and for adult females there was a positive relationship ($R^2=0.74$). From the work carried out, it had been found that both methods could be used to estimate weights of the tortoises using their respective equations. The equation for straight carapace length was $\text{Log } Y = 2.47\text{Log } X + 0.2$ (Y = weight in grammes; X = length in cm). The equation for curved carapace length was $\text{Log } Y = 2.51\text{Log } X - 0.15$. The curved carapace length gave a better estimation than the straight carapace length method.

Keywords: Chelonia, Testudinidae, captive maintenance

Introduction

Tortoises are terrestrial turtles within one family, the Testudinidae (Ernst & Barbour 1989). Among all reptiles, the turtle is the only one with a shell (Dorit *et al.* 1991). Burton (1975) mentioned that throughout the world, there are only seven main groups of turtles, namely the mud and musk turtles, pond and marsh turtles, sea turtles, side-necked turtles and finally the tortoises.

Tortoises form a family of about 50 species (Anon 2000). Burton (1975) reported that these land turtles live in tropical and subtropical regions of Africa, Asia, Europe, North and South America, and on certain oceanic islands. At present, only two genera of giant tortoise exist: one on the Galapagos Islands in the Pacific Ocean, the Galapagos giant tortoise (Paull, 1996) and the other one on the Seychelles islands (including the Aldabra giant tortoise, *Dipsochelys dussumieri* (Gray, 1834) also known as *Geochelone gigantea*). Captive Aldabra tortoises can also be found in the Mascarene Islands, Madagascar, Tanzania and United States (Anon 1994).

The actual number all around the world is not known as no record or survey has been carried out (Anon, 2001). The wild population on Aldabra is approximately 100,000 (J. Gerlach pers. comm.) while the captive US population is estimated to be around 1000. The populations of many tortoise species are fast declining because of habitat destruction and killing for food and other purposes. In addition, many tortoises die from diseases introduced by humans (Anon 2000). Aldabra tortoises are listed in the International Union

Conservation of Nature (IUCN) red list of threatened animals (Anon 1994) and are protected by the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES) (Anon 1996).

In Mauritius, the Aldabra tortoises were imported during the 1880's following the recommendation of Charles Darwin and other scientists, who were concerned that the Aldabra species would become extinct (Arnold 1979). There was a need to have populations on other islands as a security against extinction (Gunther 1877). Aldabra tortoises are kept in captivity mainly in private parks and public gardens. A few sugar estates also hold small collections and some people keep one or two giant tortoises as pets (Owadally 1988). Aldabra giant tortoises are protected in Mauritius by the Wildlife and National Parks Act (Anon 1993). Table 1 shows the different places where Aldabra giant tortoises were recorded .

Aldabra giant tortoises were introduced in the different gardens and parks at different times. According to Rouillard (1983) the earliest introduction dated back as far as 1881 when the tortoises were brought to Pamplemousses garden. No records of the initial stock or any subsequent introductions were found. Tortoises were brought to La Vanille park only 17 years ago. Table 2 indicates the number of giant tortoises at different times.

Little research has been carried out in the country and there are no reliable data on these animals. The objectives of this study were to collect information on the management of tortoises and data on these animals, leading to the establishment of regressions between the length and weights of juveniles, males and females adults.

Table 1 A list of the places where Aldabra giant tortoises had been recorded in Mauritius (source: Aworer 2003)

Place	Location	Number of Aldabra giant tortoises		
		Adults	Juveniles	Total
Public Garden	SSRBG ^a	19	9	28
	Balfour Garden	6	0	6
	R.E.H Garden ^b	8	0	8
Private Park	Casela bird Park	17	1	18
	La Vanille park	101	340	441
Sugar Estates	Belle Vue Mauricia	6	0	6
	Bel-air S.E	19	0	19
Others	State House	27	3	30
	Ile aux Aigrettes	16	0	16
	Le Coco Beach Hotel	2	0	2
	Chamarel	8	0	8
Total		229	353	582

Key: a: Sir Seewoosagur Ramgoolam Botanical Garden at Pamplemousses, b: Robert Edward Hart garden

Table 2 Number of tortoises present in the Private parks and public gardens (1979-2002)

Place	Number of tortoises								
	1979	1981	1983	1985	1998	1999	2000	2001	2002
Balfour	N.A	10 ^c	8 ^d	8 ^e	6 ^e	6 ^e	6 ^e	6 ^e	6
SSRBG	22 ^a	28 ^a	29 ^d	28 ^a	19	19	19	28	28
Casela	7 ^b	17 ^c	11 ^d	N.A	17 ^a	20 ^a	17 ^a	15 ^a	18
La Vanille	0	0	0	5 ^f	219 ^f	283 ^f	283 ^f	302 ^f	441

Notes: N.A – Not Available. Source: a: (Aumeer, pers. comm., 2003), b: (De Chazal, pers. comm., 2003), c: (Owadally 1988), d: (Bour 1984), e: (Dinally, pers. comm., 2003), f: (Griffiths, pers. comm., 2003).

Methods

The investigation was carried out in two private parks and two public gardens where Aldabra giant tortoises were kept in Mauritius. The private parks were the La Vanille Crocodile Park, situated in the south of Mauritius and Casela Bird park, located in the western part of the island while the two public gardens selected were the Botanical Garden at Pamplémousses (SSRBG) in the north and Balfour Garden in the centre of the island.

The weights and measurements of the straight and curved carapace lengths of the tortoises were recorded. These were carried out using simple devices available locally. All adults were measured while for the juveniles present at La Vanille park, a random sampling of 20 tortoises out of each age group were taken (group 1: <5 months, group 2: <1 year old, group 3: 1-3 years old and group 4: 3-5 years old).

Measurements of the straight and curved carapace length: The tortoises were numbered using an oil-based paint. To measure the straight carapace length, a wooden ruler was pressed against the front of the shell and another ruler was pressed against the caudal end. Finally the distance between these two points was measured in centimeters using a measuring tape. The curved carapace length was measured using a string and a measuring tape.

Weighing: Sub-adult tortoises were measured using a tarpaulin and a Roman balance. The numbered animals were made to walk on a tarpaulin (1x1m), which had three holes at each corner. Then the tarpaulin was hooked to the Roman balance (100kg) and this was lifted (Plate 3). This method could only be used for tortoises weighing under 100kg. For bigger tortoises a large scale weighing balance (140kg) was used. The animals were lifted by three labourers and placed on the large scale balance (Plate 4). Weights of animals over 140kg were obtained only at La Vanille park as a load (1000kg) was available at the park. Weights of juveniles were taken using a scale (8kg) and an electronic balance (1.5kg) at Pamplémousses garden and La Vanille park respectively.

Raw data were \log_{10} transformed to stabilise the extent of variation. All the data were analysed statistically using Microsoft Excel, Office 2000. Weight and straight carapace length and curved carapace length of the animals were regressed. Anova was used to analyse whether there is a difference between the regressions of straight carapace length and weight of the males and females and also whether there is a difference in using straight carapace or curved carapace length.

Results

Housing structure: Table 3 shows the different ways in which the animals were housed in the different parks and gardens.

From Table 3, it can be seen that adults were kept in open enclosures while juveniles were kept in closed nurseries. Basically, the goal in housing the giant tortoises should be to re-construct their natural habitat (Cohen 1994). The objectives of keeping giant tortoises in the parks can be categorised as: commercial, leisure and recreational and finally conservation. The private parks being commercials had sufficient fund to provide all the important features for the proper welfare of the tortoises as compared to the public gardens which were accessible free of charge to the visitors.

Regression analyses

Relationships between weights (g), straight and curved carapace length (cm) were established for the juveniles, adult males and females. Fig. 1 shows the relationship between the straight and curved carapace length and weights of the juveniles.

The coefficients of regression (R^2) when using straight and curved carapace methods was highly positive for the juveniles tortoises found at La Vanille. Both methods gave similar correlation coefficients. This implies that 96% of the variation in weight can be explained by the relationship between weight and straight carapace length. However 4% of the variation should be accounted to other factors. These were probably concerned with the feeding practices, health and physiological state of the animal as well as climatic factors. Fig. 2 and Fig. 3 show the regressions of the adult tortoises.

Table 3: Structure of pens/buildings, category and number of animals contained (in 2002)

Park	Pens/ buildings	Size (m ²)	Number of animals	Category	Area/ animal (m ²)	Features				
						Pond	Nest	Pool	Ground	Shade
Balfour garden	Pen	95	6	Adult	16	A	A	A	concrete	P
	Pen	493	15	Adult	33	P	P	A	Grass cover	P
SSRBG	Building	110	4	Adult	28	P	P	A	concrete	P
	Nursery	0.4	9	> 1 yr	0.04	A	A	A	Wooden box	P
Casela Park	Pen 1	308	10	Adult	31	P	P	P	Soil	P
	Pen 2	767	5	Adult	153	P	A	P	Soil	A
	Pen 3	800	2	Adult	400	P	A	P	Soil	A
	Nursery	0.5	1	>4 yrs	0.5	A	A	A	Grass	P
La Vanille Park	Pen	9334	103	Adult	90	P	P	P	Grass cover	P
	Sub-adult		119	20	8-12 yrs	10	P	A	P	
Grass cover	P									
	Nursery 1115		46	3-5yr	2.5	P	A	A	Grass, concrete	P
	Nursery 233		49	1-3yrs	0.7	P	A	A	Grass, concrete	P
	Nursery 335		54	<1 yr	1.5	P	A	A	Grass, concrete	P
	Nursery 470		47	1-3yrs	0.7	P	A	A	Grass, concrete	P

Key: P: Present, A: Absent

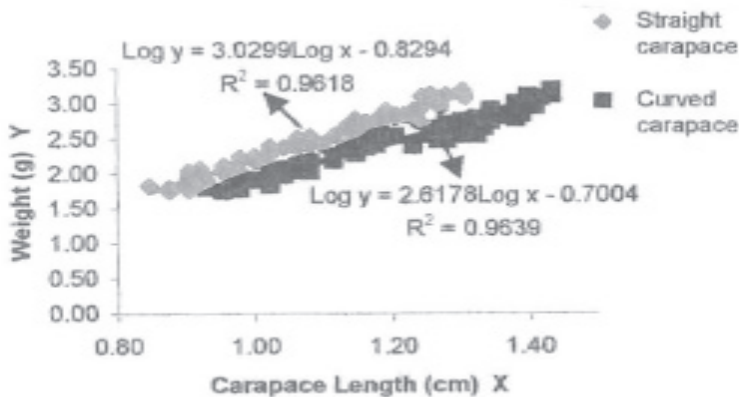


Fig. 1 Weight against straight carapace length and curved carapace length for juveniles

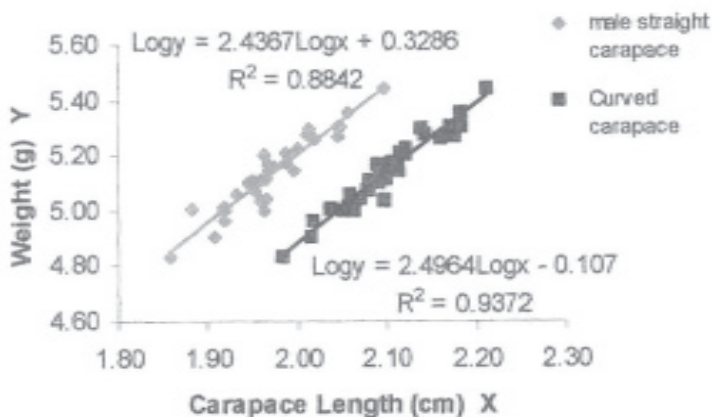


Fig. 2 Weight against straight carapace length for male adult tortoises

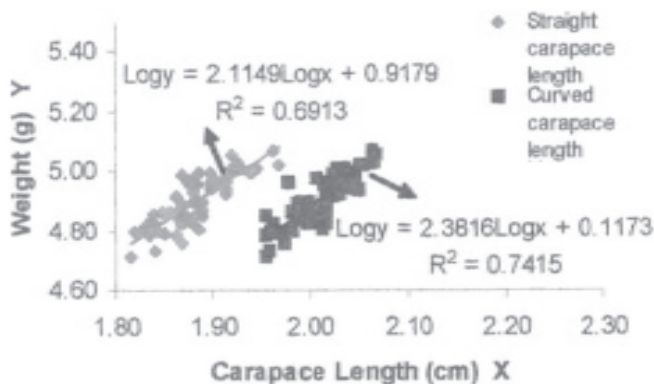


Fig. 3 Weight against straight carapace length and curved carapace length for female tortoises

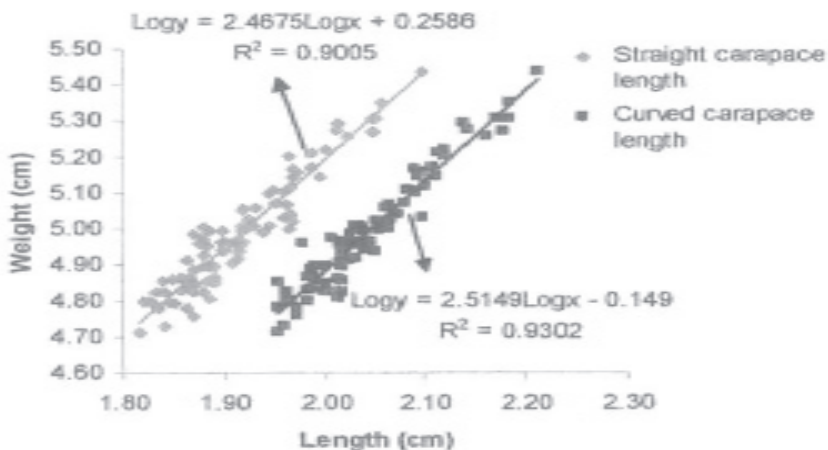


Fig. 4 Regression of adult tortoises using the straight and curved carapace length method.

Again, both R^2 demonstrate a fairly high positive correlation between weight and the straight and curved lengths of male tortoises. It can be seen that the curved carapace length gave a greater R^2 compared to the regression between straight carapace and weight of the animals.

A comparison of the regressions of adult males and females showed that $F_{cal}(2.59) < F_{table}(3.18)$ (Appendix 1) indicating that there was no significant difference between the regression of straight carapace length and weight of adult males and females at 5% level. This might be because data collected for the males and females were not from the same age groups.

From these values, it may be deduced that at the juvenile stage, the relationship between weight and length is stronger than at adult stage as juveniles grow more rapidly than adults and after sexual maturity (16-30 years) the rate of growth of adults starts to decrease. This is especially significant for females as they invest their resources into egg production instead of growth.

Comparison of the straight carapace and curved carapace lengths as predictors of weight found no significant difference between the two methods as $F_{cal}(1.23) < F_{table}(1.40)$, (Appendix 2). This implies that both methods could be used for estimating the weights of the Aldabra giant tortoises. The curved carapace method gave a better estimation, as the use of the wooden rulers in the straight carapace method might not give accurate results.

Conclusions

The Aldabra giant tortoises were kept in the private parks and public gardens to serve various purposes namely, commercial, leisure and recreational and finally for conservation purpose. The two private parks and SSRBG -Pamplemousses maintained the tortoises at a satisfactory level whereas at Balfour Garden improvements are needed. From the investigation, it can be concluded that the straight and curved carapace lengths can be used to estimate the animals' weights. The curved carapace length method would give a better estimation than the straight carapace length and moreover can be measured more easily. The regression analysis could be performed for other Aldabra tortoises found in zoos all around the world. This would be a good indicator of the assessment of health status of the animals.

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Appendix 1: Difference in regressions of adult males and adult females

Source	SS	Df	Ms	F	
Residual male	0.07	29	0.00		
Residual female	0.13	54	0.00		
Total Residual	0.20	83	0.00		
Residual (M+F combined)	0.21	85	0.00		
Difference in regression	0.01	2	0.01	2.59	
		From table:		3.18	F calculated < F table (NS)

Appendix 2: Difference in regressions of adult tortoises using straight and curved length

Source	SS	Df	Ms	F	
Residual straight length	0.21	85	0.00		
Residual curved length	0.15	85	0.00		
Total Residual	0.35	170	0.00		
Residual (straight + curved combined)	0.13	84	0.00		
Difference in regression	0.22	86	0.00	1.23	
58		From table:		1.40	F calculated < F table (NS)

Factors influencing emergences and nesting sites of hawksbill turtles (*Eretmochelys imbricata*) on Cousine Island, Seychelles, 1995-1999

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Abstract: Nesting hawksbill turtles were studied on Cousine Island, Seychelles from 1995 – 1999. Emergences were highest during November and December, and most (91.0%) took place between October and January when the beaches were most stable and the general wind speeds were at a minimum, with 99.4% emergences occurring during daylight. There was no correlation between emergences and tidal conditions, lunar cycles, daily wind, rainfall, and eroding or depositing beaches. Most nesting took place on or beyond the upper third of beaches. There did not appear to be any special selection for sunlit or shaded conditions, or for vegetation presence or absence. Ultimately choice of a nest site appears to be related to high-tide level and sand moisture level.

Key words: Reptilia, Testudines, Cheloniidae, marine turtles, population size

Introduction

Although the occasional green turtle (*Chelonia mydas*) is found nesting on the granitic island of Cousine, Seychelles Republic, hawksbill turtles (*Eretmochelys imbricata*) form the bulk of the breeding population on the island, and any further reference to turtles is of this species. Little previous information has been published on marine turtles on Cousine Island except for an estimate of numbers of hawksbills believed to nest there (Frazier 1984), a brief general description of numbers and breeding (Bourquin & Hitchins 1998). Some turtle monitoring started during December 1991 when beachings, tracks, nestings and turtles seen were recorded. No turtles were tagged until the 1993/1994 nesting season, and initially only nesting turtles were tagged. Tagging of non-nesting turtles was started during the 1995/96 nesting season. Collection of more detailed information on nesting began intensively during the 1995/1996 nesting season and continued until the 1998/1999 season.

The Republic of Seychelles comprises of some 51 islands and islets. Forty of these, the inner islands, are formed of Pre-Cambrian granite. The granitic islands lie between 4-5° latitude south and 55-56° longitude east. Geologically they are part of the Seychelles bank, a shoal area of some 31,000 square km with water depths of less than 60m, surrounded by ocean 4 to 5 km deep. Cousine Island, at 4°20'41''S and 55°38'44''E, is just over 1 km long and 400m wide at its widest point, and is 25.7ha in extent (Stoddart 1988).

All the granitic islands of the Seychelles group experience a humid tropical climate. The relative humidity varies little from 75% to 80%. Mean monthly temperature ranges are between 25.7 and 27.8°C with average diurnal ranges being 3-4.2°C. Known temperature extremes are 19.3°C and 32.8°C. The coolest months are July and August and the hottest are April and May. Annual rainfall and length of dry/wet seasons vary considerably from island to island, and seasonally on each island.

South-east Trade winds (Trades) occur from May to October; lighter and more variable north-west Monsoon winds (Monsoons) occur from December to March. Winds are variable with frequent calms during the transition months of April and November. Highest

mean wind speeds occur from June to September (13.9-17.1km per hour - south-east winds), and for the rest of the year mean wind speeds range from 5.9-10.4km per hour. Tropical cyclones have not been recorded for the granitic Seychelles, although strong winds frequently occur for short periods, especially during storms (Stoddart1988).

Cousine's landscape is strongly influenced by rock formations, dominated by the ancient granite. The highest point rises to just under 77m. A sand beach lies on a section of the east to north facing shoreline, and is about 900 m long. The vegetation of Cousine has been described (Bourquin 1996). The sea within a kilometer of Cousine's shore is up to 30 m deep, and the underwater visibility is generally very good, with exceptionally clear water during calm periods. During the Trades the sea's surface temperatures in the Seychelles are 23-27°C and of intermediate salinity (34.3-35.2 ‰), with even warmer waters (28-31°C) occurring during the Monsoons. Average ocean salinities are about 35‰ and ocean surface water salinities can change depending on rainfall and evaporation (Stoddart 1988).

The main oceanic current in the Seychelles region is the south equatorial current moving from east to west, with its main flow between 8° and 14°S. The granitic Seychelles lies on the northern edge of this current. The tidal range in the Seychelles is 1 to 2 m between successive high and low spring tides, and as a result the oceanic tidal currents are weak except where a narrowing constriction in land-masses occur.

The main factors influencing water movement and wave action around Cousine are the wind speed, direction and water depth. Patterns of wave refraction, current and eddy formation strongly affect the near shore benthic communities (Kelly 1996).

Methods

Climate - Rainfall, cloud cover, wind speed and direction on Cousine were recorded daily.

Location marking - The dune crest of Cousine's beach was marked at 30m intervals, starting at the end of the beach in the south, with numbered markers which were used as reference points for all emerging turtles and their beach activities (Fig. 1).

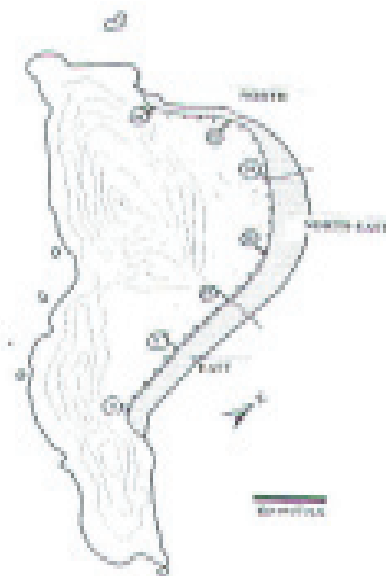


Fig. 1. Beaches of Cousine

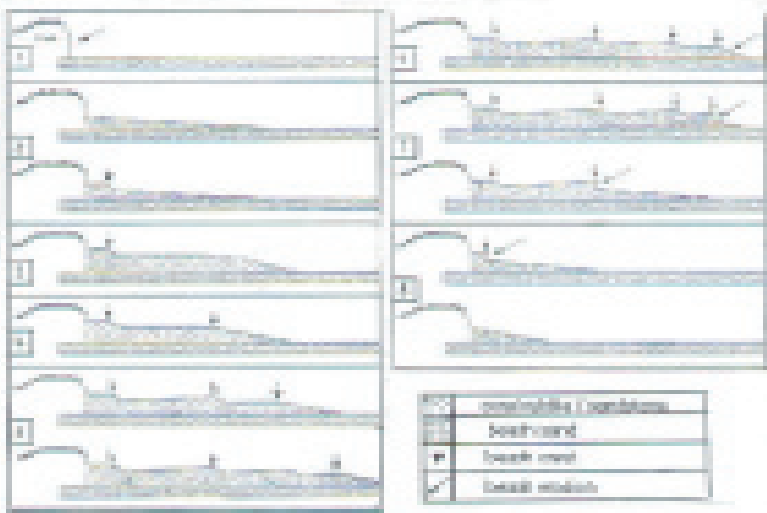


Fig. 2 Beach profiles on Cousine

Patrols - Patrols were undertaken daily from August to April at 1-1.5h intervals whenever possible, normally between 06:00-18:30h, sometimes earlier and later during nesting peaks.

Soil / sand characteristics - Ten soil samples were taken from 300-450mm below ground level on 3 May 1999 from the upper beach, dunes and behind the dunes – all areas to which hawksbills have access for nesting. These were analysed by the Seychelles Bureau of Standards. Soil textural classes were determined using the chart of Loxton (1961). Definitions were based on van der Eyk *et al.* (1969).

Beach and dune characteristics - The beach was divided into three sections for comparative purposes, the east section, the north-east section and the north section - each being about 300m long (Fig. 1). Beach widths were recorded and mapped monthly at spring tides from each dune crest marker beacon, at right-angles to the sea. Mean beach sand depths were estimated, and approximate beach sand volumes were calculated. Beach profile characteristics were classified into eight categories (Fig. 2). Dune characteristics and vegetation cover were obtained by observation and following plant identifications and descriptions in Bourquin (1996).

Emergences - A female turtle crawling on to dry land was considered to do so with the intention of nesting, whether she was successful or not, and we therefore considered any emergences as part of the nesting season. All turtle emergences were recorded, indicating points of emergence in relation to the dune crest markers, subsequent activity and, where possible, the times spent by the turtles on land. First seasonal emergences were considered as being the beginning of the breeding season, and last emergence as the end.

Results

Climate - Although rainfall was measured on Cousine island for a short time only (1992-1999), there were notable monthly fluctuations and extended dry periods. The longest continuous dry period known for Cousine was 61 days during June to August 1993, while periods of 30-40 days were not uncommon during any dry season. A dry period (rainfall under 100mm per month) varied from year to year but usually fell between June and December, with a consist-

ently wet month (September) sandwiched in between. This did not hold true for September 1997, which was dry, and for August 1997 (usually a dry month) during which 579mm of rain fell in 6 days. The most consistent rainfall months were September, December and February, the least consistent being June, July and October (Tables 1 & 2).

Beach characteristics.- The north and part of the north-east beaches were most stable from near the end of the Trades (October) to after the beginning of the Monsoons (January). During the Trades sand from the eastern beach was removed and transported away, while there was accumulation of sand and widening of the north beach. The process was reversed during the Monsoons. Because of erosion and deposition beach widths could vary from 123m wide to being completely washed away. Estimated beach sand volumes ranged from a total of 70,980 cu. m at the end of the Trades to 108,720 cu. m at the end of the Monsoons (Fig. 3).

Indications were that sand was not simply redistributed on the beaches from one part to another, but was also being brought ashore from marine deposits during the Monsoons, and removed from the beach to the sea during the Trades. The greatest volume of sand at the end of the Monsoons was on the east beach, while during the Trades the largest volume was on the north beach.

The changing of sand volumes by erosion and deposition changed the beach widths and profiles. While most dunes remained stable, the beach crest and the beach could change considerably, often very quickly. Stability of the dunes was indicated by the presence of vegetation, especially large trees (*Casuarina equisetifolia*), which gave an idea of how long the system had remained stable. For one of Cousine's dunes, this was for 30-40 years until dune erosion by tidal action during 1998 caused the collapse of some of the older trees on the dune crest. The beach crests could vary in height from being almost indistinguishable to 2m high. The dunes could be less than 0.5m high to over 4m high. Beach crests and dunes had faces varying from gently sloping to vertical (Table 3).

Table 1 Annual rainfall (mm), Cousine Island, Seychelles

Period	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00
1 July-31 Dec	423.5	351	1182	646.3	650.2	1805.3	505.4	816.4
1 Jan-31 June	1115	1014	828.2	1104	936.6	1025.5	828.9	868.5
Total	1538.5	1365	2010.2	1750.3	1586.8	2830.8	1334.3	1684.9

Table 2 Rainfall during turtle breeding seasons, 1992/93 - 1999/2000, Cousine Island.

Years	Rainfall in mm.							
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
1992/93	46.0	125.0	18.0	44.0	177.0	444.0	317.0	42.0
1993/94	40.5	156.0	69.0	14.0	68.0	383.0	268.0	54.0
1994/95	284.0	209.0	115.0	197.0	192.0	208.0	162.5	89.0
1995/96	27.9	164.7	176.5	64.0	169.8	240.0	288.2	283.5
1996/97	47.3	175.0	41.9	200.8	146.4	159.6	92.8	226.6
1997/98	603.7	245.0	429.4	262.7	249.0	349.3	147.1	149.5
1998/99	16.0	152.0	8.2	168.3	127.5	330.9	232.8	125.2
1999/00	138.0	113.6	44.1	342.0	157.2	120.8	324.8	277.6
Mean	150.4	167.5	112.8	156.1	160.9	279.3	229.2	155.9
SD	190.5	40.1	130.3	113.4	48.8	106.9	80.3	90.1

Soil and sand characteristics: All samples were classified as sand, with over 90% of the mass containing particles over 20 microns in diameter. The nature of the beach sand was variable due to periodic erosion and deposition cycles. High or low organic content resulted from deposition of debris, especially *Sargassum* seaweed and “needles” (branchlets) of *Casuarina equisetifolia* trees. On the dunes themselves, and behind them, the presence of up to 5% organic matter was determined by the presence of vegetation, and the drainage of rain-water.

Day-length and emergences - Day length in Seychelles range from 11:50-12:24h. Turtle emergences can start on Cousine with day-length at about 11:57h (August) and can end during April (day-length of just over 12h). The greatest number of emergences occur during daylight hours exceeding 12:05h, peaking between 12:15-12:24h. With the beginning of daylight hour decrease (beginning of January), the number of emergences decreases rapidly. Since numbers of nests closely parallel emergences, nesting follows the same pattern (Fig 4).

Table 3 General characteristics of the Cousine Island beach.

Character	East Zone 0 – 10	North-east Z one 10 – 20	North Zone 20 - 30
Dune height in m (mean, range)	1.93(0.9–4.1)	0.98(0.3–1.7)	0.61(0.2-1.7)
Dune face slope very steep to moderately steep (%)	100	50	0
Dune face slope moderate to gentle (%)	0	50	90
Barrier of rocks on beach (%)	0	0	10
Dune ridge and base shaded (%)	0	18	65
Ground cover accessible to turtle (%)	0	50	100

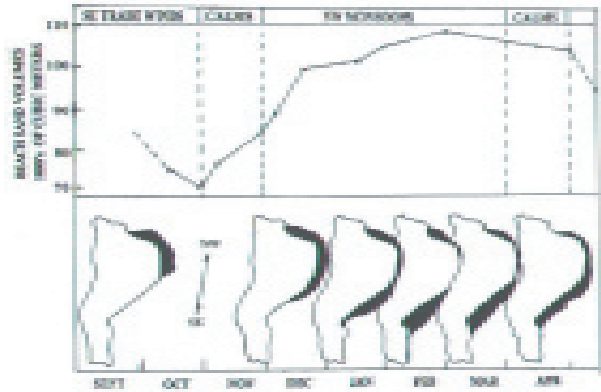


Fig. 3 Beach movement patterns on Cousine

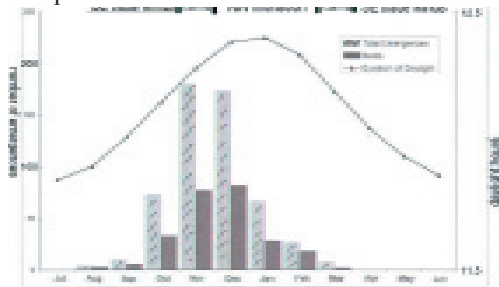


Fig. 4 Seasonal patterns of nesting on Cousine

Times of emergence - Times of turtle emergences for the 1995/96 to 1998/99 nesting seasons are given in Table 5.

First emergences were fairly evenly spread from 07:00-16:00h, with a peak from 1600-19:00h, while very few turtles (0.55%) emerge before 05:00h and after 1900h. Turtles emerging more than once on the same day, after not nesting on their first emergence, generally do so after midday. The distribution of hawksbill nesting emergences given by Mortimer and Bresson (1999) do not take second or more emergences into account, but used all emergences. Their results indicate a lower mean annual nesting emergence for the period 18:00-07:59h (13.8% compared to 18.3% on Cousine), and a higher mean for the period 14:00-15:59h (20.1% compared to 15.4% on Cousine). The remaining mean percentages of the emergences are within 2% of each other. Diamond (1976) found that nearly half the nesting attempts over two seasons on Cousin were made between 1500-1800 h, during this study 34.1% of all emergences were made during this period, which included nesting attempts as well as emergences not leading to nesting attempts.

Time of emergence related to tides - During the years 1995 to 1999, there was no significant favoured beaching time related to daily outgoing or incoming tide ($\chi^2=4.03$, $df=3$, $P>0.25$) (Table 6). This supports Diamond (1976) who reported no significant correlation between emergences and tidal state at Cousin Island, although Garnett (1979) indicated that there was a strong tendency for hawksbills to beach close to the time of high tide on Cousin Island, but only a slight tendency towards this was found on Cousine.

Emergences related to lunar cycle - Emergences related to tidal changes of the lunar cycles are shown in Table 7. The turtles show no predeliction for emerging at any particular phase of the moon during their first emergences ($\chi^2=4.12$, $df=7$, $P>0.75$), or for all emergences ($\chi^2=11.41$, $df=7$, $P>0.12$). Garnett (1979) found hawksbills nesting more during neap tides than during spring tides on Cousin.

Table 5 Times and numbers of emergences (n=366 1st emergences, n=42 2nd or more on same day) during day and night, Cousine Island, 1995-1999, tagged turtles only. * indicates separations between divisions on which percentages are based.

Emerg.	Time in hours (00's)															
	5-6	6-7*	7-8	8-9	9-10*	10-11	11-12	12-13*	13-14	14-15	15-16*	16-17	17-18	18-19*	19-20	
night																
1st	8	11	28	21	28	34	20	20	27	23	27	54	39	24	1	1
%	5.2		21.0			20.2			21.0			32.0			0.6	
2nd	0	0	0	2	1	2	0	4	3	9	4	9	6	2	0	0
%	0.0		7.1			14.3			38.1			40.5			0.0	
Total	19		80			80			93			134			2	
%	4.7		19.6			19.6			22.8			32.8			0.5	

Table 6 Effect of daily tide changes on emergences (n=539), 1995-99, only first emergence on any day for any individual included. H = high, M = mid, L = low, n = number of emergences.

	Outgoing tide		Incoming tide		Combined tides	
	H to M	M to L	L to M	M to H	M to H	M to L
N	153	128	122	136	309	250
%	28.4	23.7	22.6	25.2	55.3	44.7

Effect of calms and winds on emergences - Emergences were compared with wind speed and direction for a 90 day period between 1st October and 23 December 1995, and 21-26 January 1996 (Table 8). There were no significant differences between the frequency of emergences and the frequency of the wind conditions ($\chi^2=6.52$, $df=8$, $P>0.58$).

Most of the emergences occur during November and December, when there was a general period of variable winds and calm periods (November) and the beginning of the NW monsoons, which are lighter and more variable than the trade winds (Fig. 3). During this period the beaches are relatively stable (Fig. 3) therefore providing more stable nesting sites

Effect of rainfall on emergences - The correlation between rainfall and emergences is shown in Table 9. There is no particular rainfall period chosen by turtles in which to emerge as the frequency of the days in each category is not significantly different from the frequency of the turtle emergences for each of the categories ($\chi^2=9.82$, $df=4$, $P=0.044$).

Table 7 Turtle emergences related to lunar cycles, 1995/6-1998/9.

*1 = new moon + one day either side; 2 = 4-5 day period before neap tide during the rising moon; 3 = neap tide and one day either side; 4 = 4-5 days before full moon; 5 = full moon + one day either side; 6 = 4-5 day period before neap tide during the waning moon; 7 = neap tides + one day either side; 8 = 4-5 day period before new moon. ** 1st emergences of any tagged turtle for any one day, or 1st emergence of a series of consecutive emergences over several days by any tagged turtle. *** All untagged emergences

Lunar condition*	1	2	3	4	5	6	7	8
Emergences n**	31	45	23	49	32	43	23	48
% of total n (294)	10.5	15.3	7.8	16.7	10.9	14.6	7.8	16.3
Emergences n***	28	31	18	34	26	23	17	21
% of total n (198)	14.1	15.7	9.1	17.2	13.1	11.6	8.6	10.6
All emergences	59	76	41	83	58	66	40	69
% of total (492)	12.0	15.5	8.3	16.9	11.8	13.4	8.1	14.0
Days per lunar condition (n=711)	69	104	70	108	68	114	69	109
% of total	9.7	14.6	9.8	15.2	9.6	16.0	9.7	15

Table 8 Effect of wind on turtle emergences. L – light; M – moderate; S - strong

Wind direction	SE		SW		NW		NE	N	Calm	Totals
Wind speed	L	M	S	L	L	S	L	L		
Number of days	39	8	3	2	18	2	2	1	15	90
% of total period	43.3	8.9	3.3	2.2	20.0	2.2	2.2	1.1	16.7	100
Emergences	29	4	0	2	11	2	3	2	13	66
% of total	44.0	6.1	0	3.0	16.7	3.0	4.5	3.0	19.7	100

Table 9 Correlation between selected rainfall conditions and turtle emergences

1 = rain (at least 5mm) on day of emergence; 2 = rain 1 day before ; 3 = rain 2-3 days before ; 4 = rain 4-5 days before ; 5 = rain 6 or more days before.

	Selected rainfall conditions				
	1	2	3	4	5
Days (n=751) with selected conditions, and % of total	173 (23.0%)	105 (14.0%)	134 (17.8%)	85 (11.3%)	254 (33.8%)
Emergences (n =290)	73	39	33	41	104
% of total	(25.2%)	(13.4%)	(11.4%)	(14.1%)	(35.9%)

Emergence, nesting and beach localities - Emergences were highest on the north beach and lowest on the east beach, the greatest number of emergences occurring at point 29 and the lowest at point 7 (Fig 5, Table 10). The differences were significant both for emergences ($\chi^2=105$, $df=2$, $P<0.0001$) and for nests ($\chi^2=131.04$, $df=2$, $P<0.0001$).

Nesting and beach width - The greatest number of emergences and nesting incidences were on wide beaches, while the least number took place on narrow beaches (Table 11). The differences in the incidences of nests were significant ($\chi^2=218.6$, $df=2$, $P<0.0001$)

Nesting and beach condition - There was no significant difference between numbers of nests on eroding or depositing beaches ($\chi^2=0.32$, $df=1$, $P>0.5$) (Table 12).



Fig. 5. Distribution of emergences on Cousine

Table 10 Emergences, nesting and beach localities

Emergence result		Beach			Total
		East	North-east	North	
Nest	23	63	167	253	
No nest		82	102	133	317
Total emergences		105	165	300	570
Emergences/total		18.4%	29.0%	52.6%	100%
Nests/ emergences		21.9%	38.2%	55.7%	44.4%

Table 11 Turtle emergences related to beach width.

Emergence result		Beach width			Total
		< 25m	25-50m	>50m	
Nests		11	49	193	253
No nests		73	53	191	317
Total emergences		84	102	384	670

Table 12 Emergences and nests related to eroding or depositing beaches.

Emergence result		Beach condition		Totals
		Eroding	Depositing	
Nests		131	122	253
No nests		142	175	317
Total emergences		273	297	570

Table 13 Emergences and nesting success related to beach profile types.

Beach Type	Total emergences	Number of nests	Nests / emergences
1	1	0	0%
2	67	18	26.9%
3	6	4	66.7%
4	166	85	51.2%
5	119	50	42.0%
6	20	5	25.0%
7	142	77	54.2%
8	49	14	28.6%
Total	570	253	44.4%

Table 14 Nesting positions on beach, A = zones 0-15, B = zones 15-30. * Indicates a significant difference between A and B in 3 different zones (χ^2 , $P < 0.01$).

	Position on beach			
	Dune and behind	Upper third	Middle third	lower third
A. Nest sites (n=46)	9 (19.6%)	33(71.7%)	1 (2.2%)	3 (6.5%)
B. Nest sites (n=180)	46 (25.5%)	97(53.9%)*	21 (11.7%)*	16(8.9%)*

Table 15 Exposure of nests to the sun, A = zones 0-15, B = zones 15-30. * Indicates that significantly more (χ^2 , $P < 0.01$) turtles nested in the full sun between zones 0-15.

	Degree of exposure to sun	
	Full sun	Shade (partial + full)
A. Nest sites (n=46)	35 (76.1%)*	11 (23.9%)
B. Nest sites (n = 180)	96 (53.3%)	84 (46.7%)

Nesting and beach profile - Of eight beach profile types (Fig.5), most emergences were on types 4 and 7 (54% of total emergences). The beach types with the highest nesting success rates were 3, 4 and 7 (Table 13). Although there were no significant differences between the ratio of nests to emergences on the beach profile types ($\chi^2=15.19$, $df=7$, $P=0.026$), there were significant differences in the emergence choices for beach profiles made by the turtles ($\chi^2= 401$, $df=7$, $P<0.0001$).

Nest localities - Nest sites were mainly in the upper third of the beach or on the dune crest (Table 14), that is, above high tide mark, and almost equally in full sun or shade (Table 15) in the area between zone markers 15 and 30, but favouring open areas between zones 0 and 15. Although there is also a significant difference between nest site position for the dune and behind, it is not included in Table 14. This is because it is very difficult for turtles to access this position between zones 0-14 (15 is accessible) due to a steep to vertical dune crest face. The results in the table clearly indicate that turtles appear to prefer nesting in the upper third of the beach and the dune, when the latter is accessible.

The area between zones 15 and 30 had all the options of shade and beach positions available to turtles wishing to nest. For the most part the other beach sections did not (see Table 3), and it was with some difficulty that the turtles were able to climb to the dune crest to nest in most of this section. Grigg (1993) said that turtles generally chose open areas in which to nest on Aride Island (Seychelles), in contrast to observations by Garnett (1978) and Frazier (1984), for Cousin island. We think that the presence or absence of vegetation is not a direct factor influencing nesting site choice, and certainly on Cousine the number of

turtles nesting in or out of shade were about equal where a choice was available. We believe that nest site choice ultimately depends on the ability of the turtle to dig a nest-hole, and the characteristics of the beach. If the sand is too dry the nest-hole sides will collapse, and therefore it is likely to be soil moisture which is directly affecting nest site choice. Areas under shade or near vegetation are more likely to retain moisture than sand on open beaches, and this together with the choice of nest sites above high tide marks would explain the locations of the nest sites on Cousine. Where restricted nest site choices occur, the turtles will either not nest, or will nest in what may turn out to be marginal or poor sites.

In a few cases turtles appeared to be under stress to complete nesting, in extreme cases travelling very short distances (15m) to complete nesting and return to the sea. Such nests are subject to flooding at the next high tide, especially with a degrading beach. If there is physical stress involved (leading to an urgent need to lay eggs), then the norms of turtle nesting behaviour are likely to be disrupted.

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Inter-island nesting by hawksbill turtles (*Eretmochelys imbricata*) in Seychelles

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During studies on hawksbill turtles conducted on Cousine Island, Republic of Seychelles, during 1965 – 1999 (Hitchins *et al.* 2003), 45 turtles originally tagged on other Seychelles’ islands (Cousin and Aride) were recovered from Cousine. Regrettably there are some details not available to us regarding these recoveries, and possibly of other recoveries made on other islands in the Seychelles. The number of recoveries of turtles tagged on other islands and the seasons during which they were recovered are given in Table 1. Records of five turtles tagged on Cousine and which have been found on other islands are shown in Table 2. These records indicate that some 50, out of a breeding population of 162 females (147 tagged individuals, and an estimated additional 15 untagged nesting individuals), or 31% of the population, will breed on more than one island in the Seychelles

Although these records are unfortunately minimal, they show that a fair number of nesting individuals moved freely from island to island if, perhaps, the conditions on the originally chosen nesting beaches were unsuitable for one reason or another.

This opportunism is clearly a good survival mechanism. Because of the restricted nesting areas on the small islands, and the reported high degree of disturbance on the beaches of the larger islands, (Mortimer 1984 & in press) any protected beaches are of great importance to the survival of turtles in the Seychelles. The 40 granitic islands of the Seychelles are clustered between latitude 4-5° S and longitude 55-56° E, and none of the islands are more than 90km apart. These distances are easily travelled by hawksbills, adults being able to travel at least 1936km (Meylan 1999). Frazier (1984) had reported hawksbills tagged on Cousin apparently attempting to nest on Praslin, an island a few kilometers away from Cousin, and both Diamond (1976) and Garnett (1978) found that although Seychelles hawksbills showed a strong tendency to return to the same area to renest, some might renest on nearby islands. It now appears that opportunistic nesting by hawksbill turtles in the Seychelles is of greater magnitude than earlier observations indicate. There appear to be no other published records of hawksbill turtles nesting other than on the beaches where they were previously recorded.

Table 1 Turtles recovered from Cousine originally tagged on other islands

Seasons	Numbers of turtles	
	Cousin	Aride
1992/93	1	
1993/94	2	1
1994/95	3	
1995/96	4	1
1996/97	1	
1997/98	11	1
1998/99	11	
Totals	42	3

Table 2 Use of other nesting beaches by turtles tagged on Cousine. * = L. Tideman, pers. com.

N = nests, E = emergences

Turtle no	History of emergences
3	1993/4: 28/10/93 - N1, Cousine; 14/11/93-16/12/93 - N3, Aride 1997/8: 26/10/97 - Tag added, A, no other details available; 9/12/97 - N, Aride
14	1994/5: 19/12/94 - N1, Cousine, no other records for the season 1996/7: 26/11/96-12/1/97 - N4, Cousine 1998/9: 23/12/98 - N, Cousine: 7/1/99 - E, unable to climb dune crest, Cousine 9/1/99 - N, Cousin*: 21/1/99 - E, Cousine: 22/1/99 - N, Ce: 6/2/99 - N, Cousine.
56	1997/8: 16/11/97 - N, Cousine: 28/11/97 - N, Cousin*
89	1998/9: 4/12/98 - E, Cousine: 5/12/98 - N, Cousine: 20/12/98 - N, Cousin*.
1023	1997/8: 5/11/97 - N, Cousine: 19/11/97 - N, Cousin*

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NOTES

Ghost crabs (*Ocypode* spp.) of Bird Island, Seychelles

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This article provides a brief overview of the ghost crab (Crustacea; Ocypodidae; *Ocypode*) species observed on Bird Island (3°43'S; 55°13'E), Seychelles between 21 March 2003 and 26 March 2003. This low-lying coral island lies on the northern rim of the Seychelles bank (Braithwaite 1984) and is the northern-most island. The following species were seen:

1. *Ocypode cordimana* (Desmarest, 1825). This steel-blue/grey species was regularly seen along the western beach crest in the evening. Several were also observed digging burrows on the north east beach. This species has been previously recorded on Bird Island by Haig (1984).
2. *Ocypode ceratophthalmus* (Pallas, 1772). Of the three ghost crab species seen, this was the most visually abundant. In the evening they were regularly seen digging burrows on the western beach. It is easily recognized by the plums or horns above

- its eyes, and is pale green in colour.
3. *Ocypode ryderi*, Kingsley 1881. Several individuals were seen along the eastern beach of the island. A single male specimen was collected off the north-east beach on the 26 March 2003. In appearance, it is similar to *O. cordimana*, but can be easily distinguished by its larger size, overall white/pink colouration, mauve/dark red joints, and lack of brushes on the inner edge of the propodus. The straight line carapace length and width of the collected specimen was 40.9mm and 47.3mm respectively. The only other published Seychelles locality for *O. ryderi* is Cousine Island (De Bruyn 2002), although the species was also observed on Silhouette in April 2003 (J. Gerlach pers. comm.).

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NOTES

Inconclusive published and museum bird records from Seychelles

Adrian Skerrett and the Seychelles Bird Records Committee

Since its inception in 1992, Seychelles Bird Records Committee (SBRC) has assessed all known published records of birds recorded in the Republic of Seychelles. Frequently, published sources have involved records of a particular species new to Seychelles, some of which have never been subsequently recorded. In assessing these records, it has not always been possible to confirm identification. As a result, there are now a number of species listed in the published literature attributed to Seychelles, whose occurrence in Seychelles SBRC has not been able to confirm. At the Tenth Annual Meeting of SBRC in 2001, it was agreed that it would be valuable to publish a list of these inconclusive records. It was also agreed that inconclusive museum records should also be published.

In assessing records, every effort has been made by SBRC to contact observers and obtain the fullest possible details. However, in the case of records earlier than 1992, the intervening years (or sometimes decades) have inevitably meant that further details are not available or perhaps notes have been lost.

In order to maintain the highest standards of assessment, SBRC has sometimes found it necessary to classify such records as “not accepted”, which does not necessarily imply that the Committee believes a mistake has been made, but that the available evidence

is inconclusive. SBRC have taken a cautious line, so that records with a minimum of detail (often no detail) fall into this category. This is because as we all know, the best observers can sometimes make a mistake. Also, our knowledge of bird identification in general and our knowledge of what species occur in Seychelles in particular have both evolved considerably since the original sightings were made. As a result, possible confusion species were not always taken into consideration by the observers. Inconclusive records may be re-assessed in the light of new evidence. For example, the first record of green sandpiper *Tringa ochropus* was a published record, which was not accepted on first circulation but in the light of subsequent sightings of this species was later re-circulated and accepted.

Where a specimen exists, all known museum records have been double-checked either by a member of the committee or where this has not been possible (due to the location of the museum), by a person nominated by the committee. In general, this has confirmed the original identification but in two instances, museum specimens have been of surprising species, where it is believed it may be possible that a mistake has been made.

The following list, in taxonomic order, details all published and museum records of species whose occurrence in Seychelles is currently classified as inconclusive by SBRC.

British storm-petrel *Hydrobates pelagicus* - Illustrated in Penny (1974) and described in main text as “possible in Seychelles”. No records have been considered by SBRC.

Black-bellied storm-petrel *Fregatta tropica* - Illustrated in Penny (1974) and described in main text as “Some records in nearby waters, just possible”. No records have ever been considered by SBRC.

African darter *Anhinga rufa* - One around Research Station and at West Channels, Aldabra 16 July-16 September 1972 (Frith 1974). There have been no subsequent records.

Squacco heron *Ardeola ralloides* - One at Cousin 4-5 March 1982 and one at Bird Island 7 November 1982 (Phillips 1982). There have been no subsequent records, though Indian pond-heron *A. grayii* has been recorded. Also, Madagascar pond-heron *A. idae*, which breeds at Aldabra, has been recorded as a vagrant in the granitics. Given the scarcity of *Ardeola* records, these sightings have been accepted as “*Ardeola* sp”.

Tufted duck *Aythya fuligula* - Listed in the Addendum of Feare & Watson (1984) as a record contributed second hand. Details could not be traced. There have been no further reports of this species.

Lesser spotted eagle *Aquila pomarina* - Listed as recorded in Seychelles in Feare & Watson (1984) with a caveat that this was immature and could not reliably be separated from greater spotted eagle *A. clanga*. Neither species has been reported subsequently.

Tawny eagle *Aquila rapax* - A skull of this species at the Natural History Museum, Tring, UK is labelled as “caught off Seychelles” (by J. Batty). The bird was presented alive to London Zoo on 25 March 1901 by Lord Rothschild and died on 29 November 1903. The identification has been confirmed, but the label details were too vague to confirm the record. In addition, the conventional wisdom is that the species does

Also listed for Aldabra in Penny (1974) and in Feare & Watson (1984). There are no accepted records of this species.

Red knot *Calidris canutus* - One at Victoria mudflats 21 January-31 July 1972 and 2 February-14 March 1973, possibly the same individual (Feare & High 1977). Also listed as recorded in Seychelles in Feare & Watson (1984). There have been no subsequent reports of this species, though there have been records of great knot *C. tenuirostris*. The record has been accepted as “Knot sp”.

Red-necked stint *Calidris ruficollis* - One at Victoria mudflats, 17 February 1973; one at the sooty tern colony, Bird Island, 13-14 November 1972 (Feare & High 1977). Also listed as recorded in Seychelles in Feare & Watson (1984). Some birdwatching groups to visit Seychelles have also listed this species in trip reports but no further details of sightings have been obtained by SBRC. There are no accepted records, though three other stint species are known to occur.

Jack snipe *Limnocryptes minimus* - One at Bird Island 3 September 1973 (Feare & High 1977). Also listed as recorded in Seychelles in Feare & Watson (1984). There have been no subsequent reports.

Stone curlew *Burhinus oedicemus* - Listed in Feare & Watson (1984) as a record contributed second hand. The two observers concerned are no longer alive and though it is known photographs were taken, these have not been traced. There have been no further reports of this species.

Grey phalarope *Phalaropus fulicarius* - Listed in Penny 1974. The observer is no longer alive and no details can be traced. There have been no further reports of this species.

Damara tern *Sterna balaenarum* - Small terns on Bird Island were identified as this species by Mountfort (1971). This and other reports were described in Penny (1974) with sightings attributed to Cousin, African Banks and Bird and with possible breeding in the Amirantes. However, Feare & Bourne (1978) considered reports erroneous and probably referable to little tern *S. albifrons* or more likely Saunders’ tern *S. saundersi*. No records of Damara Tern have ever been considered by SBRC, which accepts the analysis of Feare & Bourne (1978). Saunders’ tern is treated as an annual species while little tern has been recorded as a vagrant. Neither species has ever been recorded as breeding in Seychelles.

Brown-headed gull *Larus brunnicephalus* - Listed as recorded in Seychelles in Feare & Watson (1984). There have been a number of other reports, but none have ruled out confusion species, notably black-headed gull *L. ridibundus* and grey-headed gull *L. cirrocephalus*. The only small gull recorded with certainty is black-headed gull. However, some reports have failed to rule out other possibilities and in 1997, SBRC created a new category of record, “Black-headed/Brown-headed/Grey-headed Gull,” to classify such reports pending a clearer picture emerging.

Grey-headed gull *Larus cirrocephalus* - Listed as recorded at Farquhar Atoll at an unknown date in Feare & Watson (1984). The report was published second hand and the original observer is unknown. There have been no subsequent reports of this species, but see comments under brown-headed gull, above.

Horsfield’s bronze-cuckoo *Chrysococcyx basalis* - A specimen of this species is held at the Hancock Museum, Newcastle upon Tyne, UK, labelled “from the Seychelles” and the collector given as Galbraith. The identification has been confirmed, but

details were considered too vague to confirm that it had actually been collected in Seychelles, well outside the normal world range for this species.

Pallid swift *Apus pallidus* - Listed as recorded in Seychelles in Feare & Watson (1984) with a caveat that this sighting did not rule out a pale Common Swift *A. apus. pekinensis*. There have been no subsequent reports of this species.

Mottled spinetail *Telacanthura ussheri* - Two at the Old Settlement, Aldabra 7-8 December 1972 and one 3 January 1973 (Frith 1974). There have been no subsequent reports of this species. The identity of these birds was questioned by Feare (1979), who reported a sighting of little swift *Apus affinis*, a possible confusion species (a sighting accepted by SBRC).

Red-capped lark *Clandrella cinerea* - Listed in the Addendum of Feare & Watson (1984) as a record contributed second hand. The original observer of this second hand report could not be traced. This African species is not migratory and is considered very unlikely to reach Seychelles.

Richard's pipit *Anthus richardi* - Listed as *Anthus novaseelandiae* recorded in Seychelles in Feare & Watson (1984). The record to which it related when circulated within SBRC was not conclusive. There have been no subsequent reports.

Yellow-throated longclaw *Macronyx aurantiigula* - Listed as recorded in the Amirantes in Feare & Watson (1984) and in Penny (1974). The original observer of this second hand report could not be traced. This African species is not migratory and is considered very unlikely to reach Seychelles.

In addition to the above, unpublished records of the following species have been considered by SBRC but details proved inconclusive and to date no records have been accepted:

Leach's storm-petrel *Oceanodroma leucorhoa*

Western reef heron *Egretta gularis*

Humblot's heron *Ardea humbloti*

Grey teal *Anas gibberifrons*

Northern teal *Anas crecca*

White-rumped sandpiper *Calidris fuscicollis*

Kentish plover *Charadrius alexandrinus*

Asiatic dowitcher *Limnodromus semipalmatus*

Dunlin *Calidris alpina*

Pomarine skua *Stercorarius pomarinus*

Kelp gull *Larus dominicanus*

Great black-headed gull *Larus ichthyaetus*

Olivaceous warbler *Hippolais pallida*

Olive-backed pipit *Anthus cervinus*

Spotted munia *Lonchura punctulata*

In summary, there are published references to 20 species whose occurrence in Seychelles SBRC considers to be inconclusive. There are two other species where museum specimens occur, attributed to Seychelles, where SBRC considers it possible a mistake may have been made. Finally, there are a further 15 species that have been considered by SBRC where details have proved insufficient to confirm a first record for Seychelles.

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NOTES

The presence of *Scolia ruficornis* in Seychelles (Scoliidae: Hymenoptera)

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The Scoliid wasp *Scolia* (*Discolia*) *ruficornis* Fabricius was introduced to Seychelles as a biocontrol agent for the palm damaging rhinoceros beetle *Oryctes monoceros* (Greathead 1971). Subsequent to its introduction over 30 years ago there have been no published records of *S. ruficornis*.

In 2001 three scoliid wasps were observed on Silhouette island by R. & G. Gerlach. One of these was caught and is preserved in the collection of the Nature Protection Trust of Seychelles. The specimen was compared with published descriptions of African and Oriental scoliidae and was thought to be close to *S. ruficornis*, although differing in several respects. The identification was subsequently confirmed by Dr. T. Osten of the Staatliches Museum für Naturkunde, Stuttgart. In 2002 the same species was observed on La Digue and Bird island. A specimen collected on Bird island is more typical of continental *S. ruficornis*. There appear to be interesting differences between these specimens and typical *S. ruficornis*, research is continuing into the morphological diversity of the Seychelles population.

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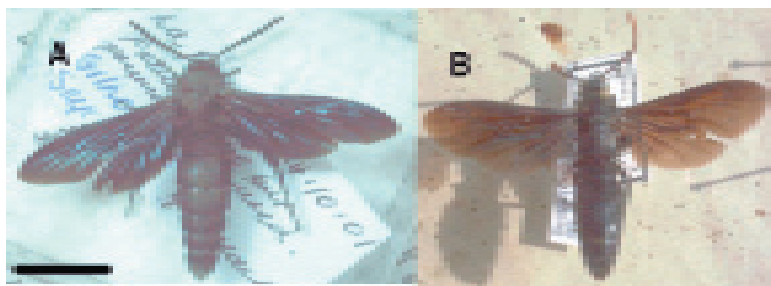


Fig. 1. *Scolia ruficornis* from Silhouette island (A) and Madagascar (B). Scale 10mm

NOTES

First record of the family Chrysididae (Insecta: Hymenoptera) from Seychelles

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In the Malagasy Subregion the family Chrysididae is represented by about 40 species. 37 species have been recorded from Madagascar, three from the Comores (Grande Comore, Anjouan, Moheli, Mayotte) and two each from Réunion, Mauritius and Rodrigues. The *Chrysis lineea* group is easily recognized by the metanotal mucro and extraordinary mesopleural projection (Kimsey 1994). It comprises three species: *C. gheudei* Guérin-Ménéville, 1842 (Madagascar) and *C. laevicollis* Buysson, 1898 (Philippines) are endemic species; the third species, *C. lineea* Fabricius, 1775, is widely distributed in the southern Palaearctic, Ethiopian, Oriental and Australian regions. Mud-nesting *Sceliphron* (Sphecidae) species are known as hosts. In Seychelles *S. fuscum* Klug, 1801 could be a possible host.

***Chrysis lineea* Fabricius, 1775**

Material: Silhouette: La Passe 3 females 6.iv.2003 leg. Gerlach; 2 females 16-22.v.2003 leg. Madl.

In the Malagasy Subregion recorded from the Comoros (Grande Comore, Anjouan, Mayotte).

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New plant records for the granitic Seychelles islands.

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The flora of the Seychelles islands has been thoroughly researched and few additions have been made to the species lists since the most recent revision (Fridemann 1994). Despite this surveys of islands in 2002 located two previously unrecorded angiosperm species, specimens of both species are in the collection of the Nature Protection Trust of Seychelles

Zanichelliaceae

Zanichellia palustris L.

A clump of horned pondweed, an introduced water weed, was found in a stream running past the Chateau St. Cloud, into the Mare Soupape on La Digue. *Zanichellia* contains two species, both cosmopolitan invaders of fresh-water systems. To date several *Zanichelliaceae* species have been recorded in Seychelles, but all as marine 'sea-grass' species.

Moraceae

Ficus densifolia Miq.

A single tree of this species was found on Souris island, off the east coast of Mahé by the author and Dr. M. van der Merwe. The tree is highly distinctive with large, pubescent leaves and bright orange fruit. The species has been described as a Mascarene island endemic and its status in the Seychelles flora is uncertain. The Souris island tree is known to have been planted on 12th February 1937 by A. Deltel and J. McQueen. The planted sapling came from a tree at Bel Age on Mahé, the parent tree is not longer alive and its origins are unknown; it may have been an indigenous tree or an ornamental introduction from the Mauritius or Reunion. *F. densifolia* has been recorded from Seychelles but without any precise data (Berg 1986) but this record was implied to be erroneous by Friedmann (1994).

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NOTES

Sea-skimming by Seychelles fruit bats

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The Seychelles fruit bat (*Pteropus seychellensis* Milne Edwards, 1887) is endemic to the Seychelles islands, with closely related species on Aldabra and the Comores. The Seychelles taxon is widespread, with breeding populations on the islands of Mahé, Silhouette, North, Praslin, Round, Aride, Felicite, Marianne and La Digue. All of these are relatively small islands (19-15,252 hectares) and none is isolated by more than 8km of open sea. Fruit bats have been seen flying over the sea between islands, visiting islands such as Cousine which do not have permanent breeding populations (P. Hitchins pers. comm.).

Over the past few years there have been anecdotal reports of Seychelles fruit bats flying low over the sea, apparently drinking. These reports, by a number of different observers, always describe a single bat flying down from a hill or mountain and dipping down to the surface of the sea. In none of the observations could it be determined for certain what the bat was doing and it was assumed that it must have been drinking. Observations have been made from the islands of Mahé, Silhouette and Aride in different months of the year (including January, March and October) but always when the sea was calm.

On 15th March 2002 a fruit bat was observed descending to the sea at Anse Patates, Silhouette island. The bat was observed from a boat approximately 300m off shore, and was estimated to be 150m away from the boat and an equal distance to the shore. Sea conditions were calm, with no air movement. The bat dipped down to the surface of the sea 4 times in the space of 2 minutes (13:07-9hrs). Due to the proximity to the bat it was possible to see that as the bat descended to the surface of the sea it dipped its breast into the water. The head was raised slightly, preventing the mouth contacting the sea. The behaviour was observed frequently in 2003; several times off the coast of Praslin and in March 2003 at least 8 bats were seen dipping down to the sea at Anse Mondon on the north coast of Silhouette. This included one bat making three repeat flights to the sea. All these bats were roosting in trees along the coast.

From these observations it is clear that the bats were not drinking but were deliberately immersing its fur in the sea. Salt-water immersion may be a strategy to remove parasites which would be expected to be abundant in a social mammal. Although this may be an effective way of removing parasites, bats using this behaviour may be at risk of falling in the sea, a risk which would be minimised by choosing exceptionally calm weather.

Of other fruit bat species *P. giganteus* has been reported to be associated with water, flying over open sea and there are reports of this species drinking sea water to obtain mineral salts otherwise lacking from the fruit diet (Novak & Paradiso 1984). However, coastal fruit bats may be expected to be able to obtain sufficient salts from sea-spray on leaves rather than

using the risky strategy of drinking over the open sea and this observation in *P. giganteus* may have been misinterpreted. Deliberate salt-water immersion does not appear to have been reported from other bats, although it may easily be confused with drinking and it could be a useful parasite removal strategy for other island fruit bat species.

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NOTES

Observations on some reptiles in Seychelles

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The lizard fauna of Seychelles plays important roles in food webs as predators of invertebrates, as consumers of the eggs of seabirds and the fish and other prey that they drop in flight and from their nests (Brook & Houston 1983) and carrion (Gerlach 1999), and as the prey of birds such as the Seychelles kestrel (*Falco araea*) and the Madagascar coucal (*Centropus toulou insularis*) and even the hunting spider *Rhitymna valida* (Blackwall, 1877) (Ineich & Ineich 1993; Matyot 2001). In spite of several studies (Cheke 1984), many gaps remain in our knowledge of the distribution, biology and ecology of all species. The following observations were made incidentally during research on lizard-insect interactions.

1. *Hemidactylus frenatus* Duméril & Bibron, 1836 (Order Squamata: Family Gekkoniidae)

I previously reported the presence of the “wandering gecko”, *Hemidactylus mercatorius* Gray, 1842 on Mahé island (Matyot 2001). We now know that the “barking gecko”, *H. frenatus*, previously known only from the outer, coralline, islands, is present on both Mahé and Praslin. During the period January 1999-June 2003 a call typical of this species, a “multiple chirp call, a gack-gack-gack suggestive of the barking of a small dog” (Marcellini 1974) was heard on many occasions in the vicinity of houses at Hangard Street, La Rosière and Hermitage and inside the radio station of the Seychelles Broadcasting Corporation (SBC) at Union Vale (all localities near Victoria on Mahé) and at the airport at Amitié on Praslin (at the latter heard in July 2002). A gecko that was uttering such a call was noticed twice, in the evening, near a wall light inside a house at La Rosière and several times, during the day, near a ceiling light that had been switched on inside the production office of SBC AM Radio at Union Vale (probably one individual demonstrating site fidelity). In the majority of cases it was not possible to identify the species with certainty because the animal retired into a crevice at the slightest attempt to approach it, but during the second sighting at La Rosière and once at SBC Radio I was able to make out small tubercles on the uniformly coloured back and spinose scales along each side of the tail as well as extremely reduced first (inner)

toes, all distinguishing features of *H. frenatus*. Subsequently, I re-examined a photograph taken at SBC Radio in March 1997 of a gecko caught by a hunting spider (*Rhitymna valida* (Blackwall, 1877)) and that appeared in the Seychelles Nation (Anon 1997; Matyot 2001). The reduced first toes and spiky outline to the tail typical of *H. frenatus* are clearly visible.

H. frenatus is one of the “edificarian” geckos (Howard *et al.* 2001), i.e. associated with buildings and other man-made structures. Believed to be native to Asia and the Indo-Pacific (Buden 2000), it is considered at present to be circumtropical in distribution (Ota 1989). In Seychelles, it was previously known only from islands in the Amirantes group and on Bird island and Platte (Cheke 1984). *H. frenatus* is the most common of the three species of anthropophilous geckos from Asia and the Pacific that are accidentally imported into New Zealand (Gill *et al.* 2001). Sperm storage for at least 36 weeks in females and the ability of inseminated females to produce an average of seven viable clutches of two eggs each while isolated from males (Murphy-Walker & Haley 1996) as well as aggressive behaviour towards other species (Ota 1989; Wells 2002) and omnivorous/opportunistic eating habits (Gupta 1998) are among the factors that explain its establishment success as a coloniser. In Australia and elsewhere, it has been shown to be responsible for the competitive displacement of other lizards (Wells 2002; S. Richards, pers. comm.), and research is under way in Mauritius to investigate its impact on native geckos (Cole 2002). It is not strictly nocturnal in Mauritius, with significant activity throughout the day, and frequently comes into contact with diurnal geckoes; moreover, parasites that are found on *H. frenatus* are infecting the native *Phelsuma ornata* Gray, 1825 with possible detrimental effects (N. Cole, pers. comm.).

In June 2002 I confirmed the presence of *H. frenatus* on D’Arros island in the Amirantes. Two or three individuals were seen at a time on walls near lights at night, both inside and outside buildings. One was caught and examined for positive identification, and was found to have large numbers of red mites clinging to its toes.

There are three possible scenarios to explain the newly-discovered presence of *H. frenatus* on Mahé and Praslin: (1) it may have been there for some time at a very low population level and is only now beginning to increase in numbers; (2) it may have been brought in accidentally from the outer islands as a result of increasing shipping and air traffic; or (3) it may have been accidentally imported recently from a locality outside Seychelles.

2. *Hemidactylus mercatorius* Gray, 1842 (Order Squamata: Family Gekkonidae)

The occurrence of this species on Cosmoledo atoll has been reported previously (Bayne *et al.* 1970), but its presence on individual islands there, apart from Menai, was not clearly established. In November 2002, during an expedition to Cosmoledo organised by the Island Conservation Society (ICS) and the CORDIO (Coral Reef Degradation in the Indian Ocean) survey group, I found *H. mercatorius* to be present on Menai, Ile du Nord, Ile du Sud-Ouest, Grande Ile and Grand Polyte. On Menai and Grande Ile it was observed on the walls of the disused settlement buildings at night, but it was also found in hollow, rotting branches, including those of *Tournefortia argentea* (“bwa taba” in Creole), on all the above-mentioned islands. Eggs, presumably of this species, were also present in some hollow branches.

3. *Phelsuma sundbergi longinsulae* Rendahl, 1939 (Order Squamata : Family Gekkonidae)

Earlier authors treated the green gecko found on Menai in the Cosmoledo group as *Phelsuma abbotti menaiensis* (Bayne *et al.* 1970). Cheke (1982) considered it to be *P.*

longinsulae menaiensis. According to Gardner (1987), it is *P. sundbergi longinsulae*. During the ICS-CORDIO expedition mentioned above I found this lizard to be common in the vicinity of the abandoned settlement on Menai. It was often observed during the day on introduced plants, including on the trunks of *Moringa oleifera* and the inflorescence stalks of the invasive *Agave sisalana*. The species was not observed on the other islands of the Cosmoledo group that were visited.

4. *Zonosaurus madagascariensis insulanus* Brygoo, 1985 (Order Squamata: Family Cordylidae)

This sub-species of plated lizard was described from specimens collected in the Glorieuses islands and on Cosmoledo. To collate the available information in a readily accessible form, the provenance of the eight specimens known to Brygoo (1985), six from the Glorieuses and two from Cosmoledo, is summarised in Table 1.

Since a specimen was collected by Vesey-Fitzgerald in 1937, there was no recorded sighting of *Z. m. insulanus* in the Cosmoledo group up to November 2002, during the ICS-CORDIO expedition, when I observed the species on several occasions on the island of Menai (Matyot 2002). Individuals were seen during daytime crawling over or near piles of dry coconut fronds on the ground near the abandoned settlement. The lizard was not particularly shy although it moved around in a “nervous” manner, continually scanning its surroundings, and on one occasion it rushed forward to grab hold of a small piece of ripe tomato that I had dropped in front of it. In Madagascar, Heying (2001) observed *Z. madagascariensis* (subspecies unknown/not specified)) preying on the frog *Mantella laevigata* Methuen & Hewitt, 1913.

Z. m. insulanus is still present on Grande Glorieuse: Mathieu Le Corre observed and photographed it there in May 1996 and May 2003 and noted that it is “quite common in various habitats, including areas covered with coconut palms (*Cocos nucifera*) as well as what remains of the native coastal forest” (Le Corre, personal communication). The assertion by Henkel & Schmidt (2000) that “the populations on Glorieuse and Aldabra (sic) can be traced back to introduction by humans” is not substantiated and appears to be one of a number of inaccuracies in their work (the presence of cinnamon in Seychelles since the end of the 15th century; orchids and bamboo being among the “typical plants” of the mid-altitude vegetation of the granitic islands, etc.).

Table 1: Specimens of *Zonosaurus madagascariensis insulanus* known to Brygoo (1985). [BM = The Natural History Museum, London, previously the British Museum of Natural History; USNM =The National Museum of Natural History, Washington, previously the United States National Museum]

Specimens	Provenance
BM 83.1.22.12	Glorieuses (collected by naval surgeon Richard Coppinger during “Alert” expedition 1882)
BM 83.1.22.13	Glorieuses (as for previous specimen)
USNM 20462	Glorieuses (collected by American naturalist William Abbott 1893)
BM 1906.8.15.2	Glorieuses (collected by “Valhalla” expedition of Earl of Crawford on Ile du Lys 1906)
USNM 231630	Glorieuses (collected by John G. Frazier after it had been caught by a cat near the meteorological station on Grande Glorieuse 1972)
USNM 231631	Glorieuses (as for previous specimen)
BM 1910.3.18.27	Cosmoledo (collected by John Fryer “on the North-East islands” - during the second Percy Sladen Trust Expedition 1908-1909)
BM 1938.8.3.27	Cosmoledo (collected by Desmond Vesey-Fitzgerald 1937)

5. *Mabuya sechellensis* (Duméril & Bibron, 1839) (Order Squamata: Family Scincidae)

Although there have been a number of studies on the skink *M. sechellensis* (Evans & Evans 1980; Brooke & Houston 1983), some aspects of the biology and ecology of the species observed on Mahé island appear not to have attracted attention so far. These include its ecological plasticity enabling it to behave occasionally as an anthropophilous species, foraging and roosting in the vicinity of and even inside houses (Cheke (1984) did point out that « the two Mabuyas ... do not hesitate to enter houses in search of scraps » but he appeared to suggest that this occurs only on rat-free islands); and its habit of roosting amid foliage on low vegetation, up to at least a metre above the ground. *M. sechellensis* also climbs readily onto shrubs and bushes to catch insects, including butterflies (Lepidoptera) of the family Lycaenidae feeding on flowers, and spiders. In May 2003 an individual was seen caught in a web of the spider *Nephila inaurata* about half a metre above the ground at La Rosière near Victoria. Closer inspection revealed that the lizard was alive and was holding the resident female spider in its jaws, suggesting that it must have jumped into the web to catch it. The skink broke free, fell to the ground and scurried away, still holding on to the spider.

Another individual was observed in 1987 swallowing a flowerpot snake (*Ramphotyphlops braminus* (Daudin, 1803)). In May 2002 yet another was found to have discovered an opening in a rearing cage, kept indoors, and to have been feeding on newly-hatched leaf insects (*Phyllium bioculatum* Gray, 1832) escaping from the cage. For several days after the opening was closed and the *Phyllium* nymphs could no longer get out the lizard was observed lurking around the cage, presumably on the look-out for nymphs that it expected to appear. This suggests that *M. sechellensis* could be a worthwhile subject for studies on perception, motivation, learning and memory (D. Lachaise, pers. comm.).

M. sechellensis was erroneously stated as the skink occurring on Ile aux Récifs in a previous report (Matyot 2001); as had been reported by Vesey-Fitzgerald (1947), *M. wrighti* is actually the species found on that island.

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NOTES

Observations on the Seychelles tree frog living in residential habitats

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The Seychelles tree frog *Tachynemis sechellensis* (Gunther, 1868) is common on the highlands of Mahé and Silhouette, where the loud call of the males - a single percussive syllable repeated 4-10 times in a slight crescendo-decrescendo - can be heard at night in the woodlands and is a typical and dominant component of the soundscape (Rocamora *et al.* 1999). On Mahé, the species can also be found in gardens and houses of the residential areas above 300m and bordering the forests of the Morne Seychellois National Park such as La Misère-Souvenir, Fairview Estate, Mission Road and Le Niol. Between 1995 and 2003, I lived with my family in a house at Fairview that permanently hosted 6 to 8 Seychelles tree frogs, and we had the opportunity to make a number of interesting observations on their morphology, behaviour and ecology.

Colour and size

Four different colour morphs were regularly found in or around the house. The large majority of these frogs (c.90%) were light green, and measured 5-7cm head and body length. Exceptionally some measured up to 8-9cm. All these were identified as adult females and were the only ones found living almost permanently inside the house, although they were found as well on various trees in the garden (pis-pis *Spathodea campanulata*, frangipanier *Plumeria obtusa* and other ornamental species). The three other morphs, dark red, brown and beige, were normally found only in the garden and very occasionally inside the house. These were smaller (4-5cm) and presumed males or young individuals.

Diurnal roosting

The tree frogs were only active at night. During the day, between dawn and dusk, they used to stay at roosting sites, either inside or outside the house, completely immobile, with no perceptible breathing movements, their eye pupil reduced to a tiny thin vertical line. The most regular roosting sites were in a first floor bathroom, a cool place well shaded by large trees from the neighbouring woodland. There, 2-3 frogs, sometimes up to 4, used to roost in a variety of places, generally on the wall in well hidden corners, sometimes behind a curtain or a piece of furniture. Some frogs also used to roost on the large window panes of the veranda. In the bathroom, they were often found inside or close by two flush-type reservoirs permanently filled with water into which they entered through small circular holes. One reservoir had larger holes compared to the other (c. 2.8 compared to 2.5cm diameter) and was clearly preferred by the frogs. Being for our own water consumption, the latter reservoir had normally its holes blocked and the frogs would then roost nearby or in the other one. When these reservoirs were checked, frogs present inside were always found close to the water level. In addition, there was in this bathroom a tank permanently filled with 50-150 litres of water, although the frogs could not get inside it. The tree frogs seemed to have a preference for roosting sites close to open water, probably because humidity was higher and facilitated their skin breathing, apparently responsible for most of their respiration during their immobile diurnal phase. Some of these frogs had distinctive black marks on the skin of their head or elsewhere and could be identified individually. We noticed that the same frog normally returned to the same roosting site over a certain period of time (several weeks to several months), although sometimes they could be found roosting for a few days in a different place nearby before returning to the original site. During the rainy days, when the humidity was high, the frogs usually went outside the house through an open window and did not return to their bathroom roost for one or more days. On several occasions they were observed during day time roosting on the leafs of exotic ornamental trees close to the bathroom. Sometimes, several frogs were observed roosting close to each other, especially in the reservoirs (up to 3 frogs roosting), but most of the time they used to roost in scattered places outside the flush reservoir. Individual frogs recognisable from a distinctive mark eventually disappeared from their bathroom roost after a few months and were almost immediately replaced by others at the same spot (inside the reservoir or behind a furniture). Sometimes they were seen again after a while somewhere else in the house, and then never seen ever again.

Nocturnal activities

During the night the frogs used to hunt for prey in or outside the house. On many occasions we observed the frogs coming out of their roosts at dusk. As daylight was diminishing, the frogs were becoming progressively active, their pupils enlarging to occupy their entire eyes to allow a good night vision. Active respiration and blood circulation became also apparent from the movement of the skin under the frogs' throat. Most of the time, tree frogs were observed hunting in the vicinity of their diurnal roost, although sometimes as far as 10-15 meters. The three tree frogs roosting in the bathroom were normally seen hunting in different rooms. Whilst one frog generally remained in the bathroom at night, the two others were observed repeatedly in different neighbouring rooms or downstairs, as if each had its own hunting area. Every time we could recognise a particular individual from some peculiar skin coloration and size patterns, we clearly observed some sort of site fidelity over a certain period of time. One particular individual was repeatedly seen coming downstairs

to the living room at night and was always back to its first floor roost the following mornings. Although we had the impression that frogs were avoiding each other when hunting, we never observed any sign of aggression or territoriality between individuals that were found close to each other. The frogs living inside the house used to hunt in complete darkness, over the white interior walls of the house or perching on various objects and furniture from where they could spot their prey and jump on them. In contrast, other frogs (normally 2 to 3) preferred to hunt close to the lights of our garage and veranda where insects were always attracted, as did house geckos *Gehyra mutilata* and day geckos *Phelsuma astriata* with which they were directly competing for insects. There too, tree frogs normally hunted in different areas (normally one in the garage and one in the veranda around each bulb) as if there was some sort of mutual exclusion, although this was not systematic. One of these frogs had for example a clear preference for a large door glass where we could easily observe its hunting behaviour. Tree frogs were trying to catch a variety of flying insects that would perch or fly close to them. We observed catching attempts on small moths, mosquitoes, flies, flying ants and termites, but very few effective captures. The best way to investigate the diet of the tree frogs would be to collect their faeces (which are very easy to find in a house environment) and identify the invertebrates present from the remains. We once observed a same frog of c. 6cm snout-vent length that had caught by a wing a large moth with a body length of c. 4cm long. After a while, the moth was able to escape, possibly because our presence created some disturbance to the frog. On another occasion, the same frog had caught a small house gecko (c. 4cm long) whose tail was coming out of its mouth. The frog kept the gecko a very long time (c. an hour) in its mouth, probably waiting for it to die before swallowing it. We observed this phenomenon only once, but it is likely that the tree frogs were able to catch such small geckos on a regular basis. Tree frogs being in that particular circumstance direct competitors and occasional predators of house geckos, it is possible that their high density in this house may have limited the abundance of geckos.

Tree frogs, presumably males, were regularly heard singing at night in the garden outside the house. We never heard any of our light green (presumed female) individuals producing any kind of sound at any time of the year.

Despite the fact that our observations were done in a very peculiar artificial environment and not in the usual natural habitat of the Seychelles tree frog, these may still contribute to improve our knowledge of this relatively common but still poorly known endemic frog of Seychelles.

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The dot underwing *Eudocima materna* (Linnaeus, 1767) (Lepidoptera, Noctuidae) in Seychelles

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The dot underwing *Eudocima materna* (Linnaeus, 1767) has had a highly unstable taxonomic history. At various times it has been placed in the subfamilies Ophiderinae and Catocalinae of the Noctuidae and in the genera *Ophideres* (Fryer 1912; Legrand 1966), *Othreis* (Pinhey 1975) and *Elygea* (Viette 1990). Here we prefer to retain the generic placement that occurs most often in recent literature. The species was first recorded in Seychelles by Fryer (1912), who, in his account of the Lepidoptera collected during the second Percy Sladen Trust Expedition to Seychelles in 1908-1909, reported that “a single specimen flew on board the schooner ‘Charlotte’ when some 40 miles south-west of Platte Island, with a light wind from the north-west after 10 days’ calm” *. There are apparently no further records of *E. materna* (Legrand 1966) until 1984 and 2001, when specimens were collected on Aldabra atoll and one of the granitic islands respectively.

Recent records

The Aldabra specimen was a male collected by John Collie on the 14th of April 1984 in the dining room of the research station on Picard island (data with specimen in Aldabra insect collection). A second male was collected by James Millett in the research house on Cousin island on the 20th October 2001 (Millett, pers. comm.).



Fig. 1 *Eudocima materna*

* The ‘Charlotte’ appears to have been a schooner that plied between Mahé and the outer islands, judging from the following extracts from the diary of Hugh Scott, entomologist of the second Percy Sladen Trust Expedition, which also indicate possible dates when the specimen was captured: “November 19, 1908: The sailing-ship “Charlotte” (Captain Parcou) returned from Aldabra two or three days ago, bringing letter from Fryer, which I got today...
February 12, 1909: The schooner “Charlotte” returned from Aldabra bringing Fryer.” (Scott, unpublished).

Description

The adult is large (wingspan c. 85mm) and relatively colourful. Forewings are patterned brown, grey and buff; hindwings and abdomen predominantly clear yellow-orange. Hindwings have a 2-10mm black margin, white marginal spots, and a 3mm central black spot, hence the name 'dot underwing' (Pinhey 1975). Females (not yet encountered in Seychelles) differ from malea in having a prominent white diagonal streak on the forewing.

Discussion

Larval foodplants of *E. materna* are Menispermaceae lianas. In Australia larvae feed on *Tinospora smilacina* (Fay 1996) and *Legnephora moorei* (Common 1990; Herbison-Evans & Crossley 2003), and on *Dioscoreophyllum cumminsii*, *Rhigiocarya racemifera* and *Tiliacora* sp. (Forsyth 1966) in Ghana. The only Seychelles Menispermaceae *Cissampelos pareira* Linnaeus, probably introduced and known only from early 20th century records from Assumption (Fosberg & Renvoize 1980; Friedmann 1994). Unrecorded Menispermaceae may occur in gardens on Mahé, but successful breeding of *E. materna* seems unlikely. Instead, it is probable that all Seychelles specimens were wind-dispersed or ship-assisted vagrants. There are many potential sources for vagrants; the species is widespread in the tropics, from India (Kalyanam 1967) to Indonesia (Fryer 1912), Australia and the Pacific (Fay 1996), throughout the Afro-tropics (Forsyth 1966; Pinhey 1975) and the Neotropics from Florida and Texas (Pogue 1999) to Brazil (Zagatti *et al* 2001). The nearest breeding population may be in Madagascar where both the moth (Viette 1990) and Menispermaceae (Dumetz 1999) occur.

In parts of its range there have been attempts to control *E. materna* (Waite 2002) as it is regarded as a crop pest: the adults pierce citrus fruits, carambola and mangoes with their barbed proboscis to feed on the juice, creating entry points for fungi and bacteria.

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